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DEVELOPMENT AND EXPANSION OF TECHNOLOGICAL AND TECHNICAL EDUCATION

THE long-awaited report on the development of higher technological education in Great Britain, prepared by the National Advisory Council on Education for Industry and Commerce, has now been issued*. It will be remembered that misgivings were expressed when the examination of this question was entrusted to that Council, rather than to the University Grants Committee, even if to do so would have involved enlarging the terms of reference of the latter body; and the result has justified those fears. The whole trend of the long-drawn-out discussion on the expansion of higher technological education has been to emphasize the desirability, if not the necessity, of the expansion of university education and technological education being considered by the same body. In fact, as the Parliamentary Secretary to the Ministry of Education admitted in the debate on education last May, neither falls within the province of the Ministry of Education; and it is to be hoped that this fact alone may induce the Minister, who has invited comments on the present report pending taking any decision on its recommendations, to leave a singularly inept report severely alone.

For the purposes of this report, the Advisory Council regards higher technological education as referring to technological education in technical colleges of a standard at least equivalent to that of a university first degree, or satisfying the educational requirements for corporate membership of a major professional institution. Nevertheless, while the Advisory Council recognizes that the provision of technological training cannot wisely be limited to one type of institution, and makes rather grudging acknowledgment of the contribution of the universities to technological education, it naïvely dismisses as irrelevant to its purpose the question of the establishment of one or more technological universities of a type new to Great Britain, or of the raising to university status of one or two existing colleges of technology. The quantitative aspect is virtually ignored, nor does the Council even discuss the question whether technological education and technical training can be given within the same institution. It is suggested, indeed, that advanced courses in technology should be concentrated as speedily as possible in colleges which are in a position to transfer elsewhere the whole, or the greater part, of their junior and less advanced work; and it would appear from this that the selected colleges would cease to fulfil the function of training technicians, for which they were originally established.

Neither qualitatively nor quantitatively is the effect of any such development on the supply and training of technicians even considered in this report. The supply and the quality of technicians is, however, a matter as vital to the industrial future

* Ministry of Education. The Future Development of Higher Technological Education; Report of the National Advisory Council on Education for Industry and Commerce. Pp. 28. (London: H.M. Stationery Office, 1950.) 1s. net.

of Great Britain as the supply and quality of technologists. Moreover, technicians are required in even greater numbers than technologists, and their training is the only *prima facie* reason for the concern of the Minister of Education with technological education. The Advisory Council disregards these considerations and treats with scant courtesy the contribution of the professional institutions, some of which have a record of more than half a century of conspicuous service in this field. It also omits any consideration of the staffing problem—whether the selected technical colleges as at present constituted and governed are able either to attract the staff or arrange the courses which would provide the desired developments and improvements. This is a matter on which Lord Eustace Percy spoke strongly in a recent address to the Education Group of the Institute of Physics.

The Advisory Council is of the opinion that the essential requirements for the development of education for technologists in the technical colleges of Great Britain lie in four main directions. With the first two of these there will be general agreement. First comes the further development of high-level courses of various kinds based on a sufficient scientific foundation, and conducted under conditions allowing the greatest possible freedom for experiment on the part of the lecturer and for research on the part of students and staff. Second, a radical improvement is necessary in the finance, staffing, equipment and accommodation of the colleges, to enable them to develop such courses, to which many, agreeing with Lord Eustace Percy, would add a change in organization. There will be a good deal of support, too, for the Advisory Council's rejection of various types of national body proposed, such as a technological grants committee for technical colleges, an association of professional institutions for raising standards, an association of colleges or departments of technology in a 'technical university' or a royal council of technology concerned with courses and awards at the first-degree level.

It is from the third and fourth of the Advisory Council's recommendations that there will be dissent. No cogent evidence is advanced in this report as to how, or why, either the establishment of new awards of high prestige to attract students to the courses and meet their desire for a higher technological qualification, or the establishment of a national educational body of high standing to appraise and assess the courses leading to such awards, and to assist in securing for technological education generally the recognition it needs, will contribute to the development of technological education in Britain. Nevertheless, besides the development of new courses of advanced technology in the technical colleges in close association with industry and with the co-operation of the regional academic boards, and the consideration by the Minister of Education of increased financial aid to the authorities and a bigger allocation of building permits, the main recommendation of the report is the establishment of a national body with the title of 'Royal College of Technologists'.

This body would not itself conduct examinations or set syllabuses or take students, but would approve suitable courses of advanced technology submitted by technical colleges under conditions appropriate to first and higher awards, and would approve the appointment of suitable external examiners to assist the colleges in setting and marking their own examinations. While the constitution of the proposed College is dealt with in some detail, the report ignores entirely the fact that any such new awards could enjoy no greater prestige than that of the institution in which they are won. Their real impress would not be that of the awarding body, however distinguished, but that of the technical colleges in which they were won.

Here we are confronted inescapably with the question of attracting highly qualified staff and of providing all the necessary equipment and amenities for a spacious education of the type required. Linked with this are the further questions whether such developments are possible while the technical colleges are owned and administered by local education authorities, and without deflecting them from the no less important function of training technicians. If, in fact, the colleges are thereby deflected from the training of technicians, the primary questions are what alternative provision is to be made for the training of technicians, and how many, and which, technical colleges are to be thus diverted to the training of technologists exclusively.

It is because the Advisory Council on Education for Industry and Commerce has ignored these fundamental issues that its report is so unconvincing and even involves the risk, as Mr. R. A. Butler was prompt to point out at the autumn conference of the British Institute of Management, that a wrong turning may be given to the development of technological education if its recommendations are adopted. Apart altogether from the question whether in the existing organization of the technical colleges under local authority administration it is, or is not, inherently impossible to provide the conditions of staff independence and the like which will attract men and women of professional calibre, it is, as Sir Frederick Handley Page, chairman of the Council of the City and Guilds of London Institute, has pointed out, difficult for a local authority to allocate to technical colleges the large sums required without imposing a heavy burden on its ratepayers and doing a possible injustice to the other types of education for which the authority is responsible. If the finance and development of technical education are not to depend upon the vagaries of local politics and the ratable resources of local authorities, some at least of the colleges must receive direct-grant aid in the same way as the universities do.

The report, indeed, provides further evidence of the need for the development of higher technological education in Great Britain being considered by the same authority as that responsible for the development of university education. Above all, it indicates the need for a quantitative approach to the whole question of technological education, both where it touches university education and where it affects the

expansion of technical education. Perhaps the Advisory Council on Scientific Policy, which although closely concerned with the matter is not directly involved, would put the weight of its authority behind such an inquiry; it should at least be able to command the support of the British Institute of Management and of leading industrialists, as was indicated in the discussion which followed Sir Ewart Smith's paper at the Birmingham meeting of the British Association.

DECLASSIFIED WORK ON UNDER-WATER EXPLOSIONS

Underwater Explosions

By Robert H. Cole. Pp. ix+437. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1948.) 42*s*. net.

A FEW weeks before the Battle of Britain, Sir Geoffrey Taylor suggested that I should attempt to calculate the pressure pulse caused by the detonation of an explosive charge of TNT in water, beginning with Prof. H. Jones's numerical values of the adiabatic of the detonation products. The calculations were the most tedious I have ever made. However, after four months I had a curve showing the form of the pulse at 50 charge-radii. For the first time I was allowed to see the experimental results, a tracing made by Sir Geoffrey from a specially secret Admiralty report, produced by Sir Geoffrey after certain formalities had been observed. The agreement between theory and experiment was encouraging. Naturally, I wanted more data, and soon I was allowed to study Hilliar's report.

Seldom does a secret scientific document compare in skill, insight and language with the outstanding scientific papers of any decade; but Hilliar's report, written in 1919, merits such comparison. Mechanical ingenuity, a sound grasp of theoretical principles, and a wide and accurate range of experimental data in a hitherto almost unknown field are all there. The formal, terse and impeccable language in which this humble scientific worker presented his results to the Lords of the Admiralty is delightful. Sir Ernest Gowers could do no better.

The ban of secrecy on this and many other reports on the same subject has now been removed, and R. H. Cole's "Underwater Explosions" gives a very fine account of the present position. The book summarizes the main results of well over a hundred reports, many of them not yet published openly. Free use is made of appropriate openly published papers and text-books. The most recent papers naturally receive greater attention than the early ones; but some of the early papers were outstanding at the time when they were written.

The subject as left by Hilliar was physics; the subject as it now stands revealed by Cole is technology. The ubiquitous cathode ray tube and the efforts of many skilful and industrious mathematicians have extended the state of knowledge shown in Hilliar's report, but only a few striking new ideas have been added.

The book is divided into ten chapters, an appendix, a bibliography and an index. The chapter headings are: the sequence of events in an underwater explosion, hydrodynamical relations, the detonation process in explosives, theory of the shock wave, measurement of underwater explosion pressures, photography of underwater explosions, shock-wave measurements, motion of the gas sphere, secondary pressure waves, and surface and other effects. The appendix develops some of the approximations special to water in the Kirkwood–Bethe theory of the spherical propagation of an explosion pulse.

Possibly the most interesting sections of the book are those giving the theory and the experiment of pulsating underwater bubbles, especially when modified by free and rigid surfaces. Apparently the essentials of this problem were first formulated by an unknown examiner in a Cambridge Tripos examination in the eighteen-fifties. Butterworth, in the Admiralty, during the interval between the two World Wars, rediscovered the problem and worked out many interesting features of underwater explosions. During the Second World War, Taylor, Herring and others made considerable extensions. An omission which is slightly disappointing is that the chapter on surface effects does not mention gravity waves caused by underwater explosions. In a purely scientific sense, the gravity waves caused by explosions are most interesting and give substance to the brilliant theories of Cauchy and Poisson.

There are very few misprints in the book, but Dr. A. B. Wood's name is mis-spelt as Ward in several places, both in the text and in the bibliography.

As I have stated, many of the papers on which Cole's book is based have not yet been published. This unfortunate situation is being corrected by the joint efforts of the United States Navy Department and the Admiralty. A compendium in three volumes on underwater explosions, containing many of the reports written during 1914–48 in America and the United Kingdom, is being prepared for open publication. No known scientific fact in the fundamental physics of underwater explosions is being withheld. This compendium, together with Cole's book, will give a comprehensive account of the subject as it stands to-day.

Cole's book is highly recommended for all physics and mathematics libraries on the grounds that it is well written, substantial and novel. Students and research workers not concerned with the subject will find much to interest them. The photographs are entertaining and illustrate the theory in striking fashion.

W. G. PENNEY

ARCHÆOLOGY AND SCIENCE

A Hundred Years of Archæology

By Dr. Glyn E. Daniel. (The Hundred Years Series.) Pp. 344. (London: Gerald Duckworth and Co., Ltd., 1950.) 21*s*. net.

ARCHÆOLOGY is, in many respects, a subject which links the humanities with science. Its chief aim is to describe the early history of man on the basis of the relics of his handiwork (with the exclusion of written records); in other words, to supplement history, to extend it back to the beginnings of mankind and to develop a sort of prehistoric social anthropology. But in addition, archæology seeks to trace the evolution of human technology and to reconstruct the ecology of prehistoric and early historic man. In these respects it is intimately connected with geology, palæontology, physical anthropology and comparative anatomy. As in the

aims of archæology, so in its methods do two fundamental branches of learning join. In part, the methods are related to those of the history of art; in part, however, they are essentially scientific, for it must be remembered that virtually all the material on which the archæologist bases his deductions is excavated from a geological context.

As a distinct discipline, archæology is scarcely more than a hundred years old. Its foundation was influenced by the great controversies about evolution and the origin of man which occupied men's minds prior to the Darwinian period. It germinated in the cabinets and museums of the classical antiquarianism of the outgoing eighteenth century. It began to enlarge its scope when stone tools of early man were found together with the remains of extinct animals on the Somme, in the caves of South Devon and elsewhere, when the Swiss lake-dwellings were discovered and explored, and when the Danish peat-bogs began to yield the treasures which led to the establishment of the three-age system of Stone, Bronze and Iron. All these were developments which occurred prior to 1850.

Dr. G. E. Daniel has undertaken to trace from these beginnings the development of modern archæology, and in particular of prehistoric archæology. In doing so, he discusses the antiquarian background of archæology, the impact of the great development of geology and palæontology about the middle of the nineteenth century, the subsequent birth of modern archæology and the unfolding of archæological activities in many parts of the world, though mainly in the countries adjacent to the Mediterranean Sea. A particularly pleasant feature of the book is the treatment of the great personalities concerned, whose life-stories are given. Mariette, Schliemann, Pitt Rivers and Sir Flinders Petrie may be mentioned as examples.

The twentieth century is characterized by an expansion of prehistoric research, especially in Europe, and by the great development of the techniques of archæological exploration, excavation and research. It is in this latest phase that science has exerted an ever-increasing influence on archæology. Theories of evolution and of palæoclimatology, methods of physical geology like the investigation of raised beaches, of river terraces and of æolian deposits, botanical methods like pollen analysis and the identification of woods, the methods of estimating absolute age which are comprised by geochronology, have all more or less profoundly influenced the outlook of the archæologist. Modern excavations such as those carried out by Prof. R. E. M. Wheeler at Maiden Castle in Dorset and at the Roman trading port of Arikamedu in South India are examples of efficient stratigraphical analysis of a sequence of deposits of which a trained geologist might be justly proud. In the field of exploration, aerial photography has come to the help of the archæologist. The real foundations of this application of a scientific technique were laid by O. G. S. Crawford, archæological officer to the Ordnance Survey of Great Britain. The archæological interpretation of air photography is rather more than a mere analysis of topographical features. Differences in the composition of the soil, and of the vegetation growing on it ('crop-marks'), play an important part.

The scientific worker who has an interest in the origins and the unfolding of human civilization will find Dr. Daniel's book profitable reading; and what else is civilization but a very complex case of animal ecology, of adaptation of a peculiar species of mammal to a variety of environments? Admittedly, the book is written from the angle of the prehistoric archæologist, not from that of the scientific man; but it is a good thing to have a definite point of view in syntheses of this kind. No doubt another author would have written a different book. It is to the credit of Dr. Daniel that he has succeeded in dealing with so much matter that this work will be useful as a source-book to all those who are interested or become involved in the developments of archæology.

F. E. ZEUNER

AN INTRODUCTION TO NEWTON

Isaac Newton

By E. N. da C. Andrade. (Personal Portraits Series.) Pp. 111+8 plates. (London: Max Parrish and Co., Ltd., 1950.) 6s. net.

PROF. E. N. DA C. ANDRADE'S book, "Isaac Newton", is the third in the series of "Personal Portraits" written by distinguished contemporary authors and published by Max Parrish and Co., each of the selected authors being invited to write about the person whose life has most deeply influenced him. In conformity with the general plan of the series, Prof. Andrade tells in a short prologue his reasons for making Newton his choice: how, as a boy, he found in Newton the "leader of Those Who Know, as against Those Who Write or Those Who Play Cricket"; how, at the university, his enthusiasm revived through reading extracts from Newton's works in Preston's "Light". He explains that his aim in the present book has been to set down what he himself when young would have liked to know about Newton.

To convince the reader that Newton is one of the great heroes of humanity, Prof. Andrade begins by showing the esteem in which Newton has been held by famous men of science, past and present, at home and abroad. This is followed by an account of his early life and of the great discoveries made before he was twenty-four: the calculus, the composition of white light, the law of gravitation. So that the magnitude of Newton's innovations may be properly appreciated, the position of science in 1665 is reviewed, and it is shown how Newton's approach to scientific problems differed from that of his predecessors.

Prof. Andrade then goes on to describe Newton's later work in optics: the reflecting telescope, which he not only designed but made entirely himself, even to the preparation of the alloy for the metallic mirror; the first published paper (February 1671/72), in which the famous experiments on the composition of white light were described; the criticism it provoked and the unfortunate effects of this criticism, especially Hooke's, on Newton's attitude to publication. In connexion with Newton's second paper (1675), in which what is generally known as his corpuscular theory of light is set down, Prof. Andrade points out that though Newton considered light to be "possibly" a stream of small swift particles of various sizes, yet in his theory of "fits of easy reflexion and easy transmission" he gave to light periodic properties just where the wave theory has to invoke them. Some account of the "Opticks" and its famous "Queries" is included here, though this work was not published until considerably later.

The next period (1675–99) saw the publication of the "Principia" (1687). Enough is said of the contents of this great work to give the reader some idea of what it achieved.

In 1699 Newton was appointed Master of the Mint, "his periods of intense devotion to science at an end". The story of the remaining years of his life is followed, in the last chapter, by an understanding and sympathetic estimate of his character.

The prologue rather suggests that this book is intended for "the young"; certainly Newton's work is presented shorn of all, or nearly all, its difficulties. It is, however, as a valuable and scholarly introduction, not only to Newton and his work, but also to the whole of this important epoch in the history of science, that the book is recommended to young and not-so-young alike. N. H. DE V. HEATHCOTE

ANIMAL BEHAVIOUR

Wild Animals in Captivity

By Dr. D. Hediger. Translated by G. Sircom. Pp. ix+207+17 plates. (London: Butterworths Scientific Publications, Ltd., 1950.) 35*s*. net.

THE study of the behaviour of wild animals in captivity has hitherto received comparatively little attention, and Dr. D. Hediger's "Wildtiere in Gefangenschaft", published in 1942, was the first attempt by a trained zoologist to collect information on the subject. An English translation of this work, revised and brought up to date, has now appeared and will be welcomed by all interested in animal behaviour. The author, director of the Basle Zoological Gardens, has had a wide experience of animals both in captivity and in the wild, to which is added a knowledge of animal psychology. The result is an authoritative treatise which may help to correct some of the mistaken notions concerning animals in captivity, usually the result of an anthropomorphic approach to the subject.

A proper appreciation and understanding of life in captivity must obviously be based on a careful study of life in the free state, yet in the case of most species this information is very incomplete, especially in such important details as territorial requirements. It is generally assumed that in Nature animals enjoy unlimited freedom of movement; but this is far from the truth, since the majority of them are not only restricted to certain geographical areas but also to particular habitats, and in addition their distribution is dependent on relations with other occupants of the territory. The author shows that by attention to such details it is usually possible, even within the restricted area of a zoological garden, to meet the physiological and psychological requirements of most species.

The quality of the environment is shown to be of the greatest importance for the welfare of animals, and many interesting examples are given of the requirements of different species in captivity. These may be fundamentally different from the human idea of comfort, as, for example, in the case of the loris, *Nycticebus coucang*, which prefers its cage to be soaked with its own urine. Apart from the physical surroundings, the biological environment is of equal importance, for some animals prefer to live in close bodily contact with other individuals, not necessarily of the same species. On the other hand, some animals prefer to be at some individual distance, and do not tolerate physical contact except during reproduction.

Special attention is devoted to the problem of food and the necessity of providing a reasonably varied diet, together with the timing and method of food presentation. Another section is devoted to breeding, and details are given of the author's method of breeding hares by the use of a double cage whereby the animals are changed over every two days, thus ensuring that their quarters are kept thoroughly clean. This is necessary since young hares are particularly susceptible to coccidiosis and become reinfected if they remain in one place for more than two days. The relationship of animals with man forms the subject of an interesting chapter in which the question of the training of animals is discussed; this is considered by the author to correspond in some respects with sport and athletics in man.

Dr. Hediger's book will be invaluable to all interested in the proper care of animals in captivity and their behaviour. EDWARD HINDLE

RETINAL RESPONSE

Optique physiologique

Tome 2: Lumière et couleurs. Par Prof. Yves Le Grand. Pp. 490. (Paris: Éditions de la *Revue d'optique théorique et instrumentale*, 1949.) 1600 francs.

THE first volume of Prof. Y. Le Grand's treatise on physiological optics dealt with the eye as an optical instrument; the eye as a receptor of radiant energy forms the theme of this second volume. The subject-matter includes the appreciation of brightness and colour, the spectral luminosity functions, colour-matching and the principles of colorimetry, brightness and colour thresholds, visual adaptation, the photochemistry and electrophysiology of the retina, theories of colour vision and colour anomalies—the whole being treated from the physicist's point of view, that is to say, attention being concentrated on results and conceptions expressible in quantitative terms.

The author's aim has been to produce a book which, while contributing to the subject, should also have instructional value. He has, in fact, included a number of problems (with their solutions) which bring out further implications or applications of the principles discussed. This feature is of a piece with the critical approach to the subject, which is in evidence throughout—and how much the more speculative developments of this subject need a critical approach. The result, in my opinion, is an account of the highest excellence—lucid, sound, terse, with an occasional half-humorous, half-sardonic comment to provide a touch of seasoning. Prof. Le Grand appears to have no particular theoretical axe to grind, and his analysis of current theoretical trends, while perhaps unlikely to satisfy completely the respective protagonists, should prove invaluable to the student.

In a very few places conclusions are reported which are no longer accepted, for example, the estimate of ten chromophore groups to a visual purple molecule (p. 366). But my main complaint—a minor one—concerns the references; although some 160 of these are listed in full at the end of the book, there are many more in the text identified only by a name and year. It would be helpful if the full references, at least for the more recent papers, could be given in a future edition, or perhaps as an addendum to the third volume which Prof. Le Grand has promised us.

W. S. STILES

The Electronic Engineering Master Index

A Subject Index to the Contents of Electronic and Allied Engineering Publications printed throughout the World from January 1947 through December 1948. Pp. xiii+339. (New York: Electronics Research Publishing Co., Inc., 1950.) 19.50 dollars.

THIS book is the third of a series covering electronic and allied engineering literature published throughout the world from 1925 onwards. It contains a cumulative index by means of which all entries pertaining to a given subject, whether they appear in this or in the earlier volumes, may be rapidly located. The present volume contains more than 18,000 entries taken from 230 major publications issued during 1947 and 1948, including 5,500 electronic and allied patents issued by the United States Patent Office. In addition, there is a bibliography of engineering books, but this is limited almost entirely to books published in the United States, although the editor expresses the hope that subsequent editions will include the books of all the technical publishers of the world.

The system employed in the "Master Index" is the simple one of classification in alphabetical order of main subject headings with sub-headings where necessary; for example, "ACOUSTICS" is followed by "ACOUSTICS, Electrical Analogies", "ACOUSTICS, Electroacoustics", "ACOUSTICS, Hearing", etc. As one would expect, with such a system a given entry may appear more than once. Thus, some of the entries under "AIRCRAFT Direction Finders" also appear under "DIRECTION FINDERS". Those entries which do not so appear seem to be of lesser importance; but in any event they are readily found if the user first consults the cumulative subject index, where he finds the numbers of all pages on which appear entries relating to direction finders. In some cases the classification may be a little surprising; thus articles on diversity reception are listed under the heading "RECEPTION, Selectivity"; but again use of the cumulative subject index ensures that the references are not missed. Cross-referencing is not dictated solely by the wording of the title; thus, an article entitled "Dipole with unbalanced feeder" appears under "ANTENNAS", and also under "TELEVISION, Antennas", since, as reference to the article shows, it is concerned with a form of antenna commonly used for television reception.

The book should be of great value to workers in the electronic field, and particularly to documentation units and patents departments.

Boron Trifluoride and its Derivatives

By Prof. Harold Simmons Booth and Prof. Donald Ray Martin. Pp. ix+315. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 40s. net.

THE chemistry of boron trifluoride has progressed rapidly during the past twelve years, and a monograph on this subject is very timely.

The preparation, analysis, physical and general chemical properties of boron trifluoride and the fluoroborates are dealt with concisely and adequately. The key sections of a book on boron trifluoride must, however, be those dealing with its use as a co-ordinating agent and in catalysis, and it is this part which is most open to criticism. While it is clear that the authors have covered the literature in detail, they make little attempt to present a critical, balanced and correlated account of the vast amount of published work, good, bad and indifferent. The main value of the monograph thus lies in the bibliography of almost a thousand references going up to January 1948; the patent literature, in particular, has been thoroughly surveyed and indexed. The majority of the errors in the monograph are small and obvious; it is to be hoped, however, that a later edition will include the evidence which refutes claims to have prepared compounds of argon and boron trifluoride.

Merely by reading this book, one can see many topics for fundamental research on the chemistry of co-ordination compounds, and for the further use of boron trifluoride as a catalyst. The task of collecting all the relevant data can have been no easy one, and the authors are to be congratulated on producing a book which, if not stimulating, is thought-provoking and invaluable to those interested in co-ordination or catalysis.

R. N. HASZELDINE

An Introduction to Electronics

By J. Yarwood. Pp. ix+329. (London: Chapman and Hall, Ltd., 1950.) 28s. net.

THIS book was primarily written for use by physics and engineering students, either post-graduate or at the universities, who are finding a knowledge of electronics of increasing importance in their work and in preparing for their final examinations. It does not pretend to contain original work, but the author has succeeded in presenting his subject in a very lucid and logical manner, so that the book can be read with interest not only by students but also by all new workers in the electronics field.

In the preparation of his subject-matter, Mr. J. Yarwood has successfully drawn on his experience as a lecturer on this subject to technical college students. He has treated the subject from a physicist's rather than from an engineer's point of view, and has been careful to avoid getting involved in detailed descriptions of engineering applications of the principles that in general he so admirably describes. The first few chapters on basic electronic theory, including fundamental electricity and magnetism and alternating-current theory and the emission and motion of electrons, form an excellent introduction to the operation of thermionic valves and their uses in amplifiers, oscillators and modulators. Other chapters describe the operation of photo-electric and cathode-ray tubes, electron optics and the electron microscope, and the operation of ultra-high-frequency devices including the magnetron and the klystron.

A chapter on contact rectifiers and amplifiers would be a useful addition, but otherwise the book is a very good "Introduction to Electronics".

L. E. RYALL

Insect Life

By Arthur Smith. (Puffin Picture Book 66.) Pp. 32. (Harmondsworth: Penguin Books, Ltd., 1950.) 2s.

SOONER or later it was inevitable that one of the popular Puffin books for children should deal with insect life. This has been prepared by Arthur Smith and maintains the generally high standard of its predecessors. The treatment of each insect or family of insects usually begins by consideration of its better-known characteristics—the chirping of the grasshopper, the long proboscis of the hazel-nut weevil, the 'cuckoo spit' of the frog-hopper—and details of life-history and anatomy are given after the young reader's attention has been caught. Nearly every example chosen is beautifully illustrated in photogravure and can scarcely fail to capture the interest of anyone who opens the book.

FIFTY YEARS AT THE ROYAL INSTITUTION*

By RALPH CORY
Librarian of the Institution

FOR one of the staff—one of the "working staff" as Sir James Dewar used to call us—to be asked to give a Friday Evening Discourse is, I think, quite without precedent and I am very conscious of the honour the Managers have conferred on me in inviting me to give a talk about my fifty years in the service of the Royal Institution.

According to tradition, on one occasion many years ago, a Friday Evening lecturer had a sudden attack of stage fright at the last moment and, being unattended, fled. Fortunately, Faraday was present and stepped into the breach. So that there should be no recurrence of a similar catastrophe, every Friday evening someone waits outside with the lecturer to ensure that he enters this theatre as the clock strikes. For many years that has been one of my duties; but to-night the position has been reversed and I have been the guarded one. I can assure you I have every sympathy with Wheatstone, the one that ran away.

The fifty years of which I am to speak began on a dull February afternoon in 1899 when I turned into Albemarle Street for the first time in search of the Royal Institution, then totally unknown to me. Outwardly the building appeared very much as it does to-day; the street perhaps was a little different, with gas lamps and cobble paving; of course, all vehicles were horse-drawn; and for some years after I came the lecture syllabus bore a request that "Coachmen may be ordered to set down with their horses' heads towards Piccadilly and to take up towards Grafton Street". But if the Institution has not changed, many of its neighbours have—or even completely disappeared, as in the case of St. George's Chapel. Brown's Hotel, however, is unchanged, and in this connexion I would like to jump forward a few years for a moment to the early days of the Second World War. The British Council proposed to produce a documentary film for circulation abroad which was called "Men of Science". It told the story of Davy and Faraday, and the Managers of the Institution allowed the relevant scenes to be shot in the Theatre and the Library. Incidentally, the script described Faraday's first meeting with Davy and it was proposed to show Faraday coming to the Institution in response to Davy's letter. This occurred in 1813, and when the producer learnt that the Corinthian columns outside the Institution—copied from the Temple of Antonio in Rome—were only added by the architect Vulliamy in 1838, it was decided that Brown's Hotel probably most closely resembled the original exterior of the Royal Institution; so one morning, with police holding up the traffic, an excited Faraday, played by Walter Hudd, dashed into the Hotel, with Davy's letter prominently displayed in his hand. Other scenes showed Faraday bringing his wife (played by Nova Pilbeam) into the Library and of both Davy and Faraday lecturing, and also the Wheatstone incident. It was a strange week in the life of the usually sedate Institution, but not without its interest and excitements.

But to go back to 1899. I had answered an advertisement in *The Times* for an "Assistant in the Office", and getting no reply was advised to call. To a callow nervous youth the Institution looked rather awe-inspiring, and I well remember it was with some trepidation that I pushed open the swing doors and entered this building for the first time. In the old entrance hall Brewster, the hall porter, sat by the foot of the stairs. He had a bushy black beard and for uniform wore an evening dress coat with large brass Royal Institution buttons. I asked a little nervously if I could see the "Assistant Secretary"—I did not know his name then. Fortunately he would see me, and I was shown into the office and I had my first meeting with Mr. Young. The upshot of that short interview was my engagement as "Assistant-in-the-Office" at a salary of 15*s*. a week paid monthly by cheque.

Many of you will remember Mr. Young—quiet, reserved and rather shy; we always worked together in perfect harmony, probably due more to his tolerance and patience rather than to my efficiency. Like Faraday, he was a Sandemanian in religious belief, and I believe he spent his holidays preaching for country ministers. Young told me that he was probably the last link in the Institution with Faraday, and while he could not honestly say he knew Faraday, he must have seen him, because he was a frequent visitor to his home, although at the time Young was too small to remember him.

Before I go on to speak of people and events, I should like to run through the rooms and libraries of the Institution as they were when I first knew them. The Newspaper Room was not quite so comfortable as it is to-day. The Library was much more severe than the present room, although the furniture is much the same. The two tunnel-like doors at the end led into the Long Library and Writing Room; they were cut through in 1896 when Dr. Mond founded the Davy Faraday Research Laboratory and gave these two rooms as an extension of the Library. The Library lighting was crude but efficient—the casing on the ceiling is not all wired, much of it being added for the sake of symmetry. When a few years later a semi-indirect system was installed, to avoid damaging the ceiling, the casing and ceiling roses were not removed; this led an American visitor to comment to me on the curious but striking decoration of the ceiling. The Ante-room was a little smaller than the present one. On the first floor also are the two new libraries I have already referred to. The Long Library was furnished with five large tables, and when later I was appointed assistant in the Library I had to fill these with exhibits each Friday evening. On the occasion of the first centenary, an exhibition of the historic apparatus of Davy and Faraday was arranged in these Libraries, and at the close of the exhibition it was decided to keep the apparatus on permanent exhibition in cases mounted on the mantelpieces. The big Spottiswood induction coil which gave a spark of eighty-two inches in air, piercing plate-glass three inches thick, was also here. This coil is now in the Science Museum. The Writing Room has changed but little; additional shelves only have been erected on either side of the doorway. In 1899 the Managers Room was at the extreme north end of the building, where the present emergency staircase leads to the street. It was a long narrow room with only one window. There was

* Substance of a Friday Evening Discourse at the Royal Institution on November 17.

a second door which led to the Model Room. Above this door was a prominent reminder—which the Chairman could not fail to see from his seat—of the date when the renewal fines for the Conduit Mead leases were due; if notice of the Institution's intention to renew any of these leases was not given on the due date they were liable to lapse. The Rumford stove, surmounted by a bust of Faraday, was a curious fixture. When once the fire was alight, the stove functioned very efficiently, but the porters found it very tricky to start. The flue ran diagonally behind the books and at the lower corner there was a movable iron trap. I have frequently seen the porter Halford soak a handful of cotton waste with methylated spirits, remove the trap, light and throw in the flaming waste, thus creating a draught and inducing the fire to burn—a risky proceeding perhaps, but certainly effective. I cannot help feeling that it was unfortunate that this stove was not preserved at the time of the rebuilding, as it was an interesting relic.

June of 1899 was the first centenary of the Institution and, new-comer as I was, I was at once plunged into the preparations for its celebrations under the dynamic personality of Prof. J. Dewar, as he was then, so there was no time for slacking. The first commemorative lecture was given by Lord Rayleigh, at which the Prince of Wales took the chair. Dewar gave the second lecture, which was very fully illustrated by experiments.

This would seem a good point for me to say a little more about Dewar, under whom I served for nearly twenty-five years. At that time he worked principally in the then "New" Laboratory. This led off the older Chemical Laboratory which, when I first saw it, was not what I had always imagined a chemical laboratory to be. The gas engines and compressors of the liquefaction plant gave it far more the appearance of an engine room. The complicated and enormous machinery were in striking contrast to the compact apparatus which will do the same work to-day. The New Laboratory was added in 1896 by Dr. Mond when he endowed the Davy Faraday Laboratory. It is now occupied by the workshop. Dewar's principal assistant was a brother Scot, Robert N. Lennox, who was an engineer and was largely responsible for the design of the compressors and liquefaction plant. His colleague and Dewar's second assistant was Mr. Heath, who was also responsible for the lecture demonstrations. He was succeeded on his retirement by Mr. Green, who retired only recently. It is a tragic coincidence that both Lennox and Heath lost an eye through explosions in the Laboratory.

Dewar has been variously described by his biographers, and he certainly was inclined to be irascible and excitable; but he had a magnetic personality and there was a something about him which far outweighed his frequent petulant outbursts. His one over-riding obsession was the Royal Institution, and for him it mattered not who or what went to the wall so long as his beloved Institution survived. I always found him very ready to listen to any reasonable argument; but he would not tolerate the slightest familiarity. When he received his knighthood, on meeting him in the Library I congratulated him as "Sir James" and was promptly told, "Not so much of the Sir, Cory". Incidentally, I was given a crisp £5 note—enormous largesse in those days—with which to celebrate his honour in due and fitting manner. Dewar had a habit of humming—more or less tunefully—as he went about the building, which gave the staff ample warning of his approach. Promptly every morning at half past ten we would hear the door shut and then his humming growing gradually lower as he came downstairs. His first visit was invariably to the office to discuss with Young any correspondence and affairs generally. Dewar certainly kept a finger on the pulse of the Institution and knew exactly what was happening in every department.

Dr. Ludwig Mond, the founder of the Davy Faraday Laboratory, was a great personal friend and frequently visited Dewar. He was a generous benefactor, and Dewar never appealed to him in vain. Mond found the stairs up to the flat rather trying and he paid for the installation of our first lift. He would not trust a suspended lift, and so a shaft had to be sunk to the same depth as the height to the second floor in order to take the ram. I remember later there was some complaint about the lift which the company disputed, and a representative called to see Dewar about it. Dewar came down and greeted him very cheerily: "Good morning—sit down, sit down". I retired discreetly through the sliding door and soon I heard Dewar's voice getting louder and louder and his fist hammering out his points on the desk. A few moments later a very subdued engineer emerged, and when the man had gone, Sir James turned to me and said: "Cory, I've told that gentleman something—I'm not sure it wouldn't be actionable". But at any rate we got what we wanted.

The outbreak of the First World War made it difficult to carry on the engineering work involved in the low-temperature investigations, and Dewar turned, as he said—"to something cheap—soap". His big bubble lasted many weeks. It was kept in the basement, and last thing each night Dewar would go down to take the readings. He told me how the little Institution cat would sit on the top of the step ladder and watch, fascinated by the changing colours of the bubble. Unfortunately the cat was killed in a lift accident, much to Dewar's grief.

No doubt Dewar was a very active personality. Passing through the library one day he found a Dr. Forbes sitting there reading. "Hullo, Forbes, how are you?" he said. "Oh", said Dr. Forbes, "as well as I can expect to be at my age". "At your age", said Dewar; "how old are you?" "Well, I'll soon be seventy", said Forbes. "Seventy", said Dewar, giving him a slap on the back that nearly made him collapse. "You're only a boy. Look at me—I'm eighty". And he went out humming an indistinguishable air. I am glad that my last recollections of Dewar are happy ones. Just before Easter in 1923, Young was ill and I was doing the office work. As I was leaving one evening the hall porter handed me a telegram from Prof. H. A. Lorentz, of Leyden, raising some query about a Discourse he was to give later in the year. My first impulse was to put it in my pocket, but on second thoughts it occurred to me that if I left it until morning, Dewar would say, "Why wasn't I shown this last night?" So I went upstairs and found him in the drawing room in front of the fire—it was a cold March evening—with Lady Dewar, a tea table between them. I showed him the wire and he immediately began to dictate a reply—but broke off and said, "No, it's getting late—we can't do anything about it to-night, see me in the morning—get along home—good night". I did not see him alive again. He worked in the laboratory later that evening and in the early hours of the following morning had a stroke from which he never recovered.

The staff paid their last tribute to him at a simple funeral service in his study, conducted by his old friend Canon Carnegie.

Sir James Dewar was succeeded as resident professor by Sir William Bragg, under whose direction the Institution became even more popular. The twenty years or so when I served here under Sir William Bragg were, I think, the happiest of all; and I know that every member of the staff here would cheerfully give of his best for him.

My memory is a little vague as to which was actually the first Friday evening I attended; but I do remember Young telling me that if I had evening clothes I should wear them; but he added, "Don't make yourself too conspicuous". My feelings that first evening may be imagined, but I survived.

The assistant librarian in 1899 was Herbert Fyfe, a young brother of Sir Hamilton Fyfe—and I used to relieve him in the Library and in this way got some insight into its working. When Fyfe resigned in 1902 to take up journalism, Young told me that when the Managers expressed the opinion that I was rather young for the post, he had pointed out to them that I would know more about the Library than a newcomer, and they agreed to give me three months trial as assistant in the Library.

Now a word or two about what Dewar used to call the "working staff". He drew up an elaborate code of rules for this "working staff", which all had to sign. If, however, anyone was guilty of an offence which was apparently not covered by the rules—as occasionally happened—the rules were promptly altered to meet the case, and we all had to sign the fresh code. I do not know how many I signed at different times.

I have already mentioned Brewster, the hall porter. There were two other porters: Halford, who succeeded Brewster as hall porter and who will be remembered by many to-day; and Lloyd, with the long patriarchal white beard. He was the resident porter and slept on the little truckle bed in the office. Richard Fowler was the house carpenter. Dick was a great character, completely absorbed in the Royal Institution, and it was generally believed that he knew every brick and the run of every pipe and wire in the building. He was gruff in manner at first but one soon got used to him. It was quite entertaining to hear him in an argument with Dewar, and he usually came off best.

The honorary secretary in 1899 was Sir Frederick Bramwell, a civil engineer and a jovial and typical Victorian. A bust of him by Onslow Ford was presented to the Institution by the Managers and some friends in 1902. It stands in the old Entrance Hall, and if you will look closely you will see that the right eyebrow is, as Sir Frederick put it, "cocked up". At the meeting at which the bust was presented, Sir Frederick said that he criticized this feature to the sculptor, who only referred him to a looking-glass, and, said Sir Frederick, "when I looked more closely in the glass I found to my surprise that Ford was right". Bramwell retired in 1900 and was succeeded by Sir William Crookes, who was an excellent secretary.

For twenty-five years of my service the treasurer was Sir James Crichton Browne, one of the outstanding personalities of the period. When I congratulated Sir James on his ninety-fifth birthday he said: "This morning the *Evening Standard* rang up, but you know I'm rather deaf and my wife answered, and said the newspaper would like my impressions of old age. I told Lady Crichton Browne to say to the *Evening Standard* that I hadn't any—I'd never experienced it". And truly, increasing deafness seemed to be the only evidence of approaching old age. I remember at the end of a general meeting, when members have the opportunity of raising any matter they wish, one member stood up and made some criticism or complaint. Sir James, who was in the chair, listened courteously and gravely, and when the member sat down he said: "Thank you—the Managers will consider what you have said", and then later, as the meeting closed, he turned to Young who was sitting beside him and whispered, "What did he say, Young?". On another occasion when I was in the office, Sir James Crichton Browne, who had been upstairs with Dewar, came into the office and said, "You know, Cory, Sir James is getting old and I have to watch his actions very closely". He was followed some time later by Dewar, who made an almost identical remark about the other "Sir James". Crichton Browne was a most faithful attendant at the Friday evening meetings and was most frequently in the chair. Although deaf, he would sit through the lecture almost without moving in just the attitude depicted in the picture in the Ante-room of a Friday Evening Discourse.

I have known many Fullerian professors of physiology, who only hold office for three years, and some of them stand out in my memory. The first I knew was Sir Ray Lankester—not unlike Dewar in disposition, but I think more surly. In addition to lantern slides he used to illustrate his lectures with numerous large diagrams. He would make Halford cover the Ante-room floor with them and give directions how he wanted them hung on the baize curtains on each side of the screen. When he wanted to refer to them in his lecture he would say suddenly, "Give me the stick". We had no optical pointer in those days and the long pointer would be handed to him. When he had made his point the 'stick' would be waved about, seeking some place to put it down, to the danger of the eyes of the occupants of the front row—and Halford would dash forward to retrieve it. Prof. Stirling, of Manchester, was another character: tall—immaculately dressed—frock coat and flowing black bow tie and 'pince-nez' on a narrow black ribbon. He would frequently send Young a post-card on the morning of his lectures, with a list of live-stock—rabbits and rats, etc.—which he wanted to illustrate his lecture in the afternoon. Halford was usually sent off to search the Seven Dials where, then as now, many animal shops were to be found. The rabbits often did not survive the lecture, and made the main dish for the porter's dinner on the following day. Stirling made a practice of keeping all his slides until the end of his lecture, when he would run through them, describing each one. His timing was amazing, and he invariably brought down the pointer from the last slide as the clock struck.

You are all, of course, very familiar with the famous Christmas Lectures adapted to their "Juvenile Auditory". I remember that I was very much impressed by the first course I heard at Christmas 1899, namely, "Fluids in Motion and at Rest", by C. V. Boys. Those who knew him will realize that the lectures did not suffer from the lack of demonstrations. Astronomy is perhaps one of the most difficult subjects to illustrate by experiments, certainly more so than physics or chemistry; but lecturers like Sir Robert Ball and Prof. H. H. Turner always succeeded in making the subject most attractive. Turner

delivered several courses of Juvenile Lectures, and in one of them he proposed to illustrate the discovery of the planet Neptune by Le Verrier by means of a short play. Dewar was very much opposed to the idea as being too theatrical; but Turner was insistent. He chose his cast from children in his audience at the first lecture and rehearsed them in the Library in the short play he had written. At the lecture the story was thus told in dramatic form by the young actors all in costume and it was a great success.

For two courses this lecture room has become almost a zoo in miniature. Sir Peter Chalmers Mitchell, when secretary of the Zoological Society of London, lectured on the "Childhood of Animals", and many young animals were lent by the Zoo as exhibits. I remember specially his pet jaguar, which was brought to the Institution in a laundry basket. He was a friendly cub and was given a dish of milk on the lecture table, which was lapped up quietly in marked contrast to the snarls and growls with which he tackled a piece of raw meat which followed, the taste of blood arousing all his savage instincts.

In 1936 Prof. Julian Huxley, who succeeded Chalmers Mitchell at the Zoo, had a lion cub brought from the Gardens for one of his lectures. While waiting for his turn to appear, young Leo was confined in the lift lobby off the long library. He did not approve of these quarters, and when the keeper went to fetch him his temper was distinctly frayed and the keeper had considerable difficulty in piloting him along the corridor to the Theatre. However, he soon settled down and after the lecture allowed himself to be petted; but the keeper kept on the alert in the background.

Another juvenile lecturer with a sense of the dramatic was Prof. James Kendall, who gave a course on "Young Chemists and Great Discoveries". He delivered the latter part of the lecture on Faraday realistically made up and dressed to impersonate the famous scientist, and the result was remarkably good. In this guise he recited parts of Faraday's famous lecture on the "Chemical History of a Candle".

I have, of course, listened to many Friday Evening Discourses, some of which were above my head, but there are one or two which stand out in my memory. Sir Squire Bancroft was a very tall man. On the morning of the Friday of his Discourse he called at the Institution, complete with eye-glass, frock coat and top hat. He was taken round the Library and also shown the lecture room and desk. Sir Squire found the desk too low and asked if it could be raised. The blocks which we still use, however, did not meet with his approval. He looked at them critically, then waved them away; thought a moment and then, "No, no; let me have some of those musty tomes I've just seen in the Library". So I had to provide two or three thick eighteenth-century folios, on which the desk was raised to a convenient height.

In 1900, during Prof. J. A. Ewing's discourse on the metals, about half-way through there came drifting into the theatre the sound of cheering, bells and whistles. I remember distinctly the quite perceptible movement among the audience and an audible sigh of relief—Mafeking had been relieved. Nobody stayed long after the lecture that evening.

Korea is in the news, and in 1904 we had a discourse on this troubled country by an ecclesiastical dignitary, the Right Honourable and Right Reverend the Count Vay de Vaya and Luskod. He created a distinct sensation by appearing in the lecture room arrayed in his gorgeous episcopal robes of scarlet and purple. I can still remember Dewar's face when he first saw the vision, and for once he was at a loss for words. The discourse was just as picturesque.

Imperial defence is a subject perhaps a little removed from the objects of the Royal Institution; but the Theatre was crowded out to hear Lord Roberts talk about it in 1906 and utter his words of warning of the German menace, so soon to be fulfilled. A few years later Captain Scott spoke of his fears for his forthcoming Antarctic expedition, from which he was never to return.

The earliest experiments in radio and the development of the thermionic valve were also described here, by Marconi and Fleming. At one of his discourses Marconi was accompanied by his beautiful bride-to-be—the news somehow leaked out and the theatre was packed; but I have a suspicion that the feminine part of the audience were more interested in the lady than in radio.

When I was first appointed to the Library, we had an MS. catalogue in two folio volumes. I had not been assistant librarian very long before, with Mr. Young, we started a shelf-by-shelf check of the Library and made out slips for every book. From these slips the present card catalogue was afterwards prepared and replaced the cumbersome two-volume MS. catalogue. The actual work of writing and arranging the cards was not started until after the outbreak of the First World War and I had been given leave to rejoin my Territorial regiment, so that I actually did not have any part in the work. If I had, I like to think that little slips like entering Savage Landor's book, "Gems of the East", under "Jewellery" would not have occurred; the book, of course, deals with the Philippines.

Dr. Rushton Parker was, I think, the most voracious reader we ever had. He was a retired medical man from Kendal, a bachelor, and was in his armchair promptly at the same time every morning with amazing regularity, and he stayed reading until 10.30 each evening. His reading ran in cycles—he would have a spell of archæology, then switch perhaps to natural history, to be followed later by biography and so on. From the librarian's point of view he had a very reprehensible habit of making pencil notes and corrections in the books he read. These were generally very useful and well justified. He would send a list to the author suggesting their incorporation in a second edition and usually received an appreciative acknowledgment. One day a member, a barrister, came to me in considerable indignation with our copy of Trevelyan's "History of England" which had been so annotated by Dr. Parker. He was very irate, and to pacify him I said that on the first opportunity I would go through the book with a rubber and erase the offending notes. "Yes, yes," he said, "but please wait until I have copied them into my copy."

Another member, interested in mathematics, found any noise, knocking or hammering, etc., very disturbing. One Saturday afternoon he was reading in the Library when hammering started near by—he retreated to the Long Library but it was still audible, so he took a chair into the lift lobby and shut the door. In those days the door to this lobby had a spring lock which could only be operated from outside, and when he wanted to leave he found he was locked in. About six o'clock, Halford, the

porter on duty, going round the Library and not seeing the member anywhere, wondered where he was, and hearing heavy breathing from the lobby opened the door, when a very dishevelled member almost fell on him, muttering, "Thank God you've come". In his endeavours to attract attention he had smashed the large plate glass window and the lift lights and hammered the door with the chair. He was completely exhausted when he was found. The lock was altered after that.

The organization of the exhibits in the Library on Friday evenings has been one of my duties, and in the early days, when I had to fill eight large tables in the three libraries, the task was frequently a problem, but we have somehow managed to get a show of some sort each evening. We have had one or two scares. One morning a diamond was missing. I recall how anxiously the porter and I got down on hands and knees and went over every inch of the carpet, and were rewarded by finding the missing jewel embedded in the pile. On another night, a blue post office Mauritius stamp had been used to demonstrate how the ultra-violet light would reveal that this one had had a corner repaired. It was, however, still very valuable, and it disappeared. I thought it was gone for good, but a few weeks later a member—a very regular attendant—wrote to me, enclosing the missing stamp which he had picked up in a post-card folder with other circulars. When tidying his desk he came across it and promptly returned it.

During the Juvenile Lectures in 1927, soon after the children had left after one of the lectures, there was an electrical explosion in the street, all our windows were blown in, the ceiling of Faraday's laboratory damaged and the vault outside set on fire. The seriousness and the risk of panic, had the explosion occurred during a lecture or as the children were leaving, convinced the Managers of the urgency of improving the exits and the question of security from fire. As a result, complete rebuilding of the northern half of the Institution was decided on and this was begun in 1929.

The present Lecture Theatre was completed in time for the celebrations (in 1931) of the centenary of Faraday's discovery of electromagnetic induction. The celebrations were organized on a scale which made the 1899 centenary seem a very small affair. Many will remember the reception of the foreign delegates at the Institution, the commemorative meeting at the Queen's Hall, followed by the special concert by the Symphony Orchestra under its conductor, Sir Henry Wood, who was a member of the Institution. There was also an evening conversazione at the Institution, with lectures by Sir William Bragg on Faraday's researches, and an exhibition in the Albert Hall of Faraday's original apparatus and demonstrations of the many industries that have grown up from his discovery.

The Second World War found me on holiday in Jersey; Mr. T. Martin, general secretary, who was on the reserve of officers, was called back to the Royal Artillery immediately, being sent later to the Instrument Production Department of the Ministry of Supply. I returned from Jersey as soon as possible, crossing on the Tuesday after the outbreak of war. In the absence of Mr. Martin, I was made deputy general secretary and, since my assistant librarian, Mr. Griffin, was also in the Army, I was left to hold the fort. The basement was made a public air-raid shelter under the Westminster City Council, and it can be imagined how Sir William Bragg and I had to cope with forms and returns. For fire-watching duties we collaborated with the Bond Street Association, and the Institution was a fire-watching post for the block and was manned nightly. A very well equipped first-aid room was organized in the photographic dark-room by Miss Deighton, Sir William Bragg's private secretary; but fortunately she had no serious cases. Although bombs fell unpleasantly near on several occasions, luckily we escaped any serious structural damage, but, of course, our windows suffered severely. Sir William Bragg took a great personal interest in eighty to ninety shelterers each night and was very popular with them.

By Sir William's death in 1942 the Institution suffered a very serious and grievous loss. He was succeeded by Sir Henry Dale. When the 'doodlebugs' were being showered on London, one Sunday morning Lansdowne House in Berkeley Square got a direct hit. The effect of the blast on our windows was disastrous, not only glass but also wooden frames being smashed. Sir Henry Dale telephoned to me and I at once came up to town. It was a cold, rainy day and we were much concerned about the books on the window shelves in the Library being exposed to the rain. However, Sir Henry and I took our coats off and, helped by my daughter who had come up with me, we managed to move some hundreds of books away until first-aid repairs to the windows made it possible to replace them.

Now my fifty years have nearly run to fifty-two. Time will not allow me to recall all the famous men I have met—professors, lecturers and members. It must suffice to say that I have seen five presidents, two Dukes of Northumberland, Lord Eustace Percy, Lord Rayleigh and our president to-day, Lord Brabazon—and have served under five directors—Sir James Dewar, Sir William Bragg, Sir Henry Dale, Prof. E. K. Rideal and for the past year under Prof. E. N. da C. Andrade.

THE GRANITIC LAYER OF THE EARTH'S CRUST

THERE has long been a widespread belief that the outer crust of the earth consists of a layer of basalt overlying ultrabasic material and that the continents are slabs of granite, floating in the denser underlying rocks. Recently, this view has been challenged on both geological and geophysical grounds, so that a lively discussion was to be expected when the subject was debated at a meeting held in the rooms of the Royal Astronomical Society on October 27. Prof. O. T. Jones was in the chair, and introduced Dr. E. C. Bullard, Prof. H. H. Read, Dr. R. Stoneley and Dr. P. L. Willmore as the principal speakers.

Dr. Bullard began by discussing the seismological observations, which show that *P*-waves observed at short distances from shallow disturbances are propagated with a velocity of 5·6–6·5 km./sec. At distances exceeding 150 km. the velocities observed are in the range of $8{\cdot}1 \pm 0{\cdot}15$ km./sec. These results indicate a change of physical properties at a depth of some 30–40 km., but it is doubtful whether there is an abrupt discontinuity, or some more gradual transition. Evidently, however, the lower layer is much more uniform than the rocks which appear at the surface. In discussing whether the range of 5·6–6·5 km./sec.

represents a layered structure or random variations within the upper regions of the crust, Dr. Bullard remarked that seismologists, perhaps by false analogy with the mesozoic structures on which their universities are so often constructed, have usually tended to favour the former alternative. This outlook, which requires that the seismic onsets should fit on to a set of linear travel-time curves, was excusable when any one earthquake provided only a few seismograms, but it produced a dangerous tendency for later workers to bias their readings in favour of preconceived ideas. Thus, continued Dr. Bullard, in the case of the Heligoland explosion, Willmore completed the reading of his records before attempting any interpretation, while an American group "searched the literature" before seeking confirmation on the seismograms. Willmore found that little significance could be attached to anything other than the first onsets. The Americans found almost exact correspondence with a multiple-layer hypothesis, but as their data had evidently been subjected to a most drastic process of selection, Dr. Bullard did not believe in their conclusions. In Europe, America and South Africa the seismological evidence for an intermediate layer is still quite inconclusive.

On the petrological side, it has been found that rocks of a most varied kind occur under the sediments. The commonest material is probably gneiss with a composition similar to that of granite. The structures of an exposed basement complex are often ten or more kilometres across, and it would be incredible for such features to exist in a thin skin, covering a homogeneous granitic layer. Gravity observations confirm that the surface variations must extend over most of the thickness of the crust, and it is probable that the basement rocks represent the 'roots' of worn-down mountain ranges. Under the oceans, seismic refraction shooting reveals higher velocities than on continents, and the granitic layer is probably absent.

Prof. Read stated that if a 'granitic layer' exists it must underlie the rocks described by Bullard. The geological evidence for its existence is only that the proportion of granite generally increases with depth. Among geologists, there is a survival of the idea that, in exposed shields, we see the primeval crust. This hypothesis is most nearly consistent with the petrology of the Brazilian shield, but remains of sediments can be found even there. If there is a primordial granitic layer, it is necessary to explain how it could separate from a basaltic magma. If not, one has to assume that early sediments somehow became granitized, and the source of the necessary acidic constituents has then to be explained. In this connexion, Rittmann has suggested that the granitized materials have condensed from the early atmosphere. On any theory, the collection of the granite into the continents is the outstanding difficulty. It has been suggested that the granitic crust was ruptured by the extraction of the moon or by the action of convection currents, but neither of these appears to be satisfactory.

Dr. Stoneley endorsed most of Dr. Bullard's remarks, but thought that seismic refraction work does provide evidence for the existence, at least locally, of an intermediate layer. It would, however, be naïve to suggest that any such layer is strictly uniform over continental distances. For surface waves of the Love type, it is possible to derive a dispersion formula for two layers of arbitrary thickness, in terms of the published velocities of S-waves for the upper and intermediate layers. Trial solutions are consistent with the relation

$$2T_1 + T_2 = 65{\cdot}5 \text{ km.},$$

where T_1 and T_2 are the thicknesses of the upper and intermediate layers, respectively. A second equation can be derived by consideration of reflected pulses from deep-focus earthquakes. The equations indicate that T_2 does not differ significantly from zero. On making the further assumption that the ocean floor is entirely basalt, it is found that isostatic equilibrium is consistent with the idea that the ultrabasic layer extends continuously under both oceans and continents.

In criticizing the P^* data from near earthquakes, Dr. Willmore said that the estimates by different authors for the properties of the intermediate layer in a given region are sometimes so discordant that the observers cannot have been reading corresponding events on their seismograms. Since the Second World War, numerous observations have been obtained from stations close to explosions and tremor sources, so that discussions can now be founded on unmistakable first arrivals. In north Germany, the velocities measured over distances between 25 and 50 km. from the Soltau explosions do not differ significantly from those observed between 50 and 100 km. from Heligoland. On the other hand, if all the data are considered in relation to a single travel-time line, there is a tendency for onsets at the shortest and longest distances to be early. This is consistent with a general tendency for the velocity to increase downwards; but gravitational and magnetic surveys have revealed crustal irregularities which might have produced a similar effect. In South Africa, a similar tendency for waves to arrive early at distances beyond 120 km. is associated with the exposure of high-velocity rock in the region where the onsets are observed. Later in the discussion Dr. Bullard mentioned that unpublished work in America has also revealed early onsets at about 100 km. from the source, and it was agreed that the balance of evidence favours a tendency for velocity to increase downwards.

Dr. Willmore mentioned the fact that most recent determinations of the velocity of P-waves within 100 km. of the source yield values higher than that of the near-earthquake P_g. Wood and Gutenberg have suggested that high-velocity material may cover the low-velocity layer, but it is equally likely for the difference to be instrumental. Short-period instruments of the type used in tremor work might be able to detect waves which filter through small bodies of high-velocity rock, while the waves detected by earthquake instruments might travel with a velocity nearer to the bulk average. Finally, it has been shown that an average value for the velocity in the crust can be determined by observing the distance at which P_n first appears on the seismograms. This average velocity is in the neighbourhood of 6·4 km. per sec. in South Africa, so that if a low-velocity layer were present, it would have to be balanced by a greater thickness with a velocity of at least 6·8 km./sec.

In the course of the discussion, various speakers quoted figures to show that velocities and densities in the sediments can be as high as those in the granitic layer. Prof. C. E. Tilley remarked that basalts do differentiate into granites on cooling, but he could advance no theory to cover the concentration of granite in the continents. Prof. R. M. Shackleton

suggested that the down-buckling of geosynclines might be the primary cause of granitization and that the presence of sediments might be incidental. Dr. G. M. Lees challenged the use of such words as 'granitic' and 'ultrabasic' to describe the undetermined material between physical boundaries, and also suggested that there is no evidence for a difference between the materials of the continents and the ocean floor. In this he was supported by a reference to the results of seismic shooting at one station in the Atlantic, but Dr. Bullard quoted unpublished work which indicates velocities of about 8 km./sec. under the Pacific.

OBITUARIES

Dr. R. S. Clark

BORN in Aberdeen in 1882 and educated there at the Grammar School and the University (M.A., 1908), Robert Selbie Clark had intended to become a schoolmaster; but the influence of Prof. J. Arthur Thomson in zoology and of Prof. J. W. H. Trail in botany made him a biologist (B.Sc., 1911). His first post, under Dr. W. S. Bruce in the Scottish Oceanographical Laboratory in Edinburgh, turned his attention to Antarctic marine life in general and particularly to fishes, and these two interests dominated his scientific life.

In 1913 Clark was appointed naturalist at Plymouth Marine Laboratory; but in the following year he joined Shackleton's ill-fated Antarctic expedition on the *Endurance*. He had many vivid and amusing stories to tell of the hardships suffered after the *Endurance* sank in the Weddell Sea, of the journey on the ice-pack and the months of isolation on Elephant Island; but his great regret was that the marine collections he had amassed so carefully were lost with the ship.

From the Antarctic, Clark returned in 1916 to a life scarcely less uncomfortable and hazardous on H.M. minesweepers during the First World War, and eventually resumed the duties of peace at Plymouth. In 1923 he returned to Aberdeen as senior naturalist to the Scottish Fishery Board, and eleven years later succeeded Dr. A. Bowman as scientific superintendent, a post later converted into the directorship of the Scottish Home Office Marine Laboratory. Under his charge, the scientific staff of the Laboratory increased in numbers and engaged in a wide variety of activities linked with the programme of the International Council for the Exploration of the Sea.

Clark himself was too critical of his own work to be a prolific writer, but his papers have a permanent value for fishery research. His earliest publications describe some of the fishes brought home by the Scottish National Antarctic Expedition; his later work all bore upon British fisheries. An examination of thousands of rays and skates resulted in a valuable and much-needed revision of the characters and nomenclature of the European species and their early stages. His contributions at meetings of the International Council included papers of importance on the characters and distribution of the larvæ of spring and autumn herring and on the influence of the size of mesh of trawl nets in regulating the escape of under-sized fishes; and his analysis of the independent stocks of haddock in European waters led to the encouraging conclusion that in any year somewhere in the area of haddock distribution a lucrative fishery would be possible.

Clark was a striking personality, an all-round sportsman, who had represented Aberdeenshire, Hampshire and Scotland at cricket and had played Association football as an amateur in the Aberdeen team, and who in maturer years retained his skill as a golfer and an angler. His scientific activities did not end with his official retirement in 1948, for since then, at the request of the International Council, he had been chairman of its Northern North Sea Committee, and took an active part in the Edinburgh meeting of the Council in 1949. He died after a short illness on September 29, and is survived by his widow, for whom much sympathy will be felt.

JAMES RITCHIE

Mr. R. H. Worth

RICHARD HANSFORD WORTH, whose death occurred on November 11, was born in Plymouth on November 5, 1868, the son of R. N. Worth, journalist, geologist, archæologist and historian of Plymouth. He was educated at Plymouth High School (now Plymouth College) and lived in his native city all his life. A civil engineer by profession, he followed his father in having very wide cultural interests. As a geologist he worked on the petrology of Dartmoor and its neighbourhood, and, in co-operation with the Marine Biological Association, contributed to our knowledge of the geology of the English Channel by a study of the rocks dredged from the sea floor. He also studied the Foraminifera.

In his professional capacity he was interested in hydrology and the water flow of rivers, and for many years was secretary and, later, recorder for the Committee of the Devonshire Association responsible for drawing up the annual statements on the climate of the county. It is not possible in the space available to list his many activities; but Hansford Worth will best be remembered as the greatest authority on Dartmoor in all its aspects. The scientifically accurate and objective descriptions he made of the antiquities, both prehistoric and historic, will be of lasting value. He first began to publish papers on Dartmoor in 1889, and many of his important records are to be found among the pages of the *Transactions of the Devonshire Association*, of which he was a past president. He was associated with the Dartmoor Exploration Committee started by Burnard, Baring Gould and R. N. Worth in 1893 for the excavation of archæological remains, and in 1897 succeeded his father as secretary of the Association's Committee on Barrows, later becoming recorder. He issued full descriptions of the sixty-one stone rows, a class of monument in which Dartmoor is particularly rich. His evidence that their orientation had no ritual significance but depended upon topographical conditions is definite, and his decision that they afforded no clue as to their function beyond that they were sepulchral monuments with barrows usually at their higher ends was typical of his independent and objective outlook. He also issued descriptions of ruins connected with tin mining on the moor, and of many other historic remains and implements.

Probably no man has known so much of the topography of Dartmoor and of its history. Many lovers of Devonshire will miss his kindly and distinguished presence, and their sympathies will be deep for his widow, who accompanied him on so many excursions to the moor. F. S. RUSSELL

Mr. A. C. Forbes, O.B.E.

By the death of Mr. A. C. Forbes, forestry circles in Great Britain and in Ireland have lost a good friend and one who was keenly interested in the forest and the work of the forest.

Mr. Forbes attended the University of Edinburgh as an arts student in the year 1890–91; he then left the University and went to Germany, to take forestry courses there. On his return to Britain the possibilities open to him were mainly in estate forestry, and for a time he was forester on the Marquis of Bath's Longleat estate. He became lecturer in forestry in 1904 at the Armstrong College of Science at Newcastle upon Tyne. It was during this period that his first book, "English Estate Forestry", was published (September 1904), and a second edition in 1906. He became director of forestry in Ireland in 1907. During the First World War he was Government controller of timber in Great Britain and was made O.B.E. for his services.

On its inauguration in 1920, Forbes was appointed to the Forestry Commission. It was during this period that he published his later book, "The Development of British Forestry". Perhaps the greatest work carried out by Forbes was that which he did for many private-estate woods in the British Isles. Certainly it was in that work that his heart was wrapped up, for it was work of which he had great knowledge. In his first book (1904) Forbes put on record what may be termed English practice of forestry on the big and small privately owned estates in the country; and this he was enabled to do adequately since he had been a forester in charge of considerable areas. He himself says that the book was intended to be suggestive rather than instructive to the practical forester; but there is a good deal more in its pages than what the practical forester at the beginning of this century was acquainted with. He showed clearly, perhaps for the first time, that both sport and landscape effect could be obtained in conjunction with a sustained annual yield of timber from the woods.

His claim that English estate forestry was sufficiently distinct from Continental or even Scottish forestry to be entitled to regard it as a separate subject has scarcely been maintained. Modifications of the management there may have to be; but these cannot be regarded as entitling the matter to be a separate subject. This being said, there is no doubt that the work of Mr. Forbes had considerable influence in shaping British forestry. E. P. Stebbing

NEWS and VIEWS

Museum of the History of Science, Oxford: Dr. C. Josten

Dr. Conrad Josten has been appointed curator of the Museum of the History of Science at Oxford, in succession to Dr. F. Sherwood Taylor, who has become director of the Science Museum. Dr. Josten studied at the Universities of Geneva, Freiburg i.B. and Bonn, and was awarded the degree of Ll.D. (*Doctor iuris utriusque*) at the University of Erlangen. From the year 1935 he took up the study of ancient scientific instruments, of which he made a considerable collection, and also interested himself in the history of alchemy and early astronomy. During the War his opposition to the Nazi regime necessitated his disappearance; but in 1948 he was able to go to Oxford and to study the Ashmolean MSS. in the Bodleian Library. Dr. Josten first published an unknown alchemical text of Robert Fludd; a critical edition and translation of the early alchemical "Letter of John Dastin to Pope John XXII"; a study of the alchemist, William Backhouse of Swallowfield, the instructor of Elias Ashmole; and during the past two years he has been working on a biography of that remarkable personage. Dr. Josten has succeeded in solving the cipher in which many of Ashmole's notes are written and will be able to show in a new light the founder of the Ashmolean Museum, whose former home is now possessed by the Museum of the History of Science.

Aeronautical Engineering at Cairo: Prof. E. W. C. Wilkins

E. W. C. Wilkins, who has just been appointed to the chair of aeronautical engineering at Fouad I University, Cairo, joined the staff of the Oxford University Engineering Science Department at the end of 1947. Since then he has taken part in the lecturing and tutoring work of the Department and, in addition, has assisted the professor of engineering science with the financial and administrative work of the Department. Immediately prior to going to Oxford, Prof. Wilkins had spent fourteen years with the Bristol Aeroplane Co., which he joined in 1934 as a technical assistant, becoming, finally, chief airworthiness engineer, his last responsibility in this capacity being the airworthiness of the Brabazon air-liner. Before going to the Bristol Aeroplane Co. he was a lecturer in engineering at London, and before that research engineer with the Ebbw Vale Steel, Iron and Coal Co. while holding an 1851 Exhibition awarded to him in 1928. He has been a member of various aeronautical committees for a number of years, and was latterly chairman of the Royal Aeronautical Society's Detail Design Committee.

Heinrich Christian Schumacher, 1780–1850

On December 28 the centenary occurs of the death of Heinrich Christian Schumacher, who in 1821 founded the *Astronomische Nachrichten*, which, wrote Grant in 1852, "has perhaps contributed more towards the improvement of astronomical science, in all its branches, than any similar publication has ever done". Born on September 3, 1780, at Bramstedt in Holstein, Schumacher distinguished himself in mathematics and astronomy and after studying at the University of Göttingen took the degree of doctor of law. At the age of thirty he was made a professor extraordinary in the University of Copenhagen, where after a year or two at Mannheim Observatory, he was elected to the chair of astronomy. In 1821, the year he founded the famous periodical, he was appointed director of the newly erected observatory at Altona, where he remained until his death. Among his other activities were the trigonometrical survey of parts of Denmark, the measurement of an arc of the meridian and the determination of the longitude of Altona Observatory. He was also for some time the collaborator with Bessel in the editing of the "Astronomisches Jahrbuch". Both his son Richard Schumacher and his nephew Christian Andreas Schumacher were associated with his work for Denmark.

Centenary of the Geological Survey of India

THE Geological Survey of India, one of the oldest official organizations of its kind in the world, is due to celebrate in January 1951 the first hundred years of its existence as an organized department. In 1846 the East India Co., on the advice of Sir Henry De la Beche, director-general of the Geological Survey of Great Britain, and of Sir Roderick Murchison, president of the Geological Society of London, appointed D. H. Williams "to investigate the Coal districts of India". After Williams's death in 1848 there was a partial break in the work, but in 1851, when Thomas Oldham was appointed "Geological Surveyor to the East India Company", the uninterrupted history of the Survey may be said to have begun. To commemorate the occasion, the Government of India has arranged a number of events in which representatives of geological surveys and learned societies have been invited to participate. The main celebrations will be held in Calcutta during January 10–14, and these will include an exhibition illustrating the history of the Department and the progress of geological discovery in India, and a commemoration ceremony on January 13. This will be followed by a tour to places of geological and mining interest in northern India, concluding at Delhi on January 28. Prior to this, however, the thirty-eighth annual session of the Indian Science Congress, and the first meeting of the Pan Indian Ocean Science Congress (attended by delegates from most of the countries of Gondwanaland), will be held simultaneously in Bangalore during January 2–8, and a number of geologists are expected to attend the Section of Geology and Geography. Further particulars with regard to the centenary celebration programme can be obtained from the Director, Geological Survey of India, 27 Chowringhee, Calcutta 13.

Forest Economy of Private Estates

IN the Institute Paper No. 25 under the heading, "The Forest Economy of Three Private Estates in Great Britain", Mr. J. J. MacGregor, of the Department of Forestry, University of Oxford (I. F. Institute, University of Oxford, 1949), contrasts the forest economy and management of three differing private estates of which the records of their woods were detailed and covered a sufficiently long period of years to render a comparison possible. The usual trouble about private estates in the past has been that though the finances of the agricultural part of the estate as also of the shootings were accurately kept from year to year, little information about the true finance of the woods was available, being often only represented by the total sum obtained when the wood was clear felled. As the writer says, "Without further considerable effort it is difficult to co-ordinate odd scraps of financial information about, say, the costs of planting, and about sales of pitwood with the ultimate function of the woodlands on the private estates where they are situated. The physical features, the scale and intensity of operations, the capital structure and the extent and variety of the various types of income, the ratio of woodland to agricultural area, and proximity to markets, are all considerations which make one private estate differ economically from another, and also greatly influence the functions of woodlands in the general economy of the estate." A general study of the history of the past appears to show "that since about 1880 estates showed a declining income from farm rents, an increase in taxation burdens and an increase in the cost of upkeep. Although rents might have increased slightly in the period of the First World War, this was more than offset by the increases in the two main expenditure items. It is less easy to generalize about the course of income from the woodlands and about other factors." In this brochure Mr. MacGregor has produced information which should prove of value to all private estate owners.

Characteristics and Uses of a Mechano-electric Transducer

SINCE its introduction to Great Britain in late 1948, the *RCA*-5734 mechano-electronic transducer has proved itself to be a valuable and versatile research tool. It is a triode-transducer intended to provide a method of translating mechanical into electrical current variations which can be observed and measured. The triode has a metal envelope which forms the anode of the valve, and consists of a plate connexion with a thin metal diaphragm at the top, through the centre of which the plate shaft extends. Displacement of the plate shaft changes the distance of the fixed grid from the plate and results in a change of plate current. The deflexion sensitivity is 40 volts per degree deflexion of the plate shaft, but the safe limit of deflexion from the normal position is half a degree. The part of the plate shaft within the valve has a minimum free cantilever resonance of 12,000 c./s., permitting, with suitable mechanical coupling to the external end of the plate shaft, measurements of vibration up to that frequency. The moving element is designed to have very low inertia. The transducer may be mounted in any position. It weighs 1·75 gm. and is cylindrical of height $1\frac{9}{32}$ in. and diameter $\frac{5}{16}$ in.

The transducer has applications in many fields. The wide variety of uses to which it may be applied includes gust-recording anemometers for wind-velocity surveys; oscillograph recording, through a diaphragm attached to the plate shaft, of tank pressures set up during the short-circuit testing of circuit breakers; the direct measurement of arterial and venous blood pressures and the record of pulsations in the arteries; pressure recording through a cardiac catheter in the interior of the human heart; and stress evaluation and vibration phenomena in the motor, aircraft and shipbuilding industries. Board of Trade authority for the importation of a small stock of transducers for the benefit of approved institutions has been granted, and colleges, medical schools and research organizations interested should apply to R.C.A. Photophone, Ltd., 36 Woodstock Grove, London, W.12.

Fungicidal Action of Disodium Ethylene *bis*Dithiocarbamate

DISODIUM ethylene *bis*dithiocarbamate (DSE), first synthesized in 1935, gave a rather erratic performance as a fungicide in the field, until Heuberger and Manns found that its performance could be improved by the addition of zinc sulphate and lime. Raymond W. Barratt and James G. Horsfall (Conn. Agric. Exp. Sta. Bull. 508; pp. 51; New Haven, U.S.A.; June 1947) conducted a laboratory investigation into the efficiency and mode of action of thirty-six analogues and homologues of the compound, using spores of the fungus *Stemphylium sarcinæforme* for the tests. It was concluded, in general, that dithiocarbamate analogues inhibit spores through two reactions: by liberating sulphuretted hydrogen, and by forming metal salts of the compound. Fungi-

cidal potency seemed to be independent of the number of sulphur atoms in the polysulphide linkage. It was found that the addition of zinc sulphate and lime greatly increased the stability of disodium ethylene *bis*dithiocarbamate through the production of zinc ethylene *bis*dithiocarbamate, and this substance is now brought forward as the real fungicide.

Mushroom Research

Some short, useful papers on mushroom pests and diseases are included in two recent numbers of the *M.G.A. Bulletin*, the organ of the Mushroom Growers' Association, Yaxley, Peterborough. A mushroom bed competitor, which is apparently *Corticium centrifugum*, is reported by Fred C. Atkins (No. 19; April 1950). In No. 20 (July 1950), B. D. Moreton contributes a well-illustrated account of mushroom pests. Sciarid, pharid and cecid flies are described, with measures of control, as are springtails, mites and minor pests. The roles of *Rhabdites* and *Ditylenchus* eelworms in mushroom beds are also discussed. C. L. Duddington has an interesting short paper, in the same number, on "Fungi that Trap Eelworms". Fifteen species of fungi are known to capture eelworms in sticky networks. *Trichothecium flagrans*, *Dactylella ellipsospora* and *D. bembicoides* are described and figured in the paper. A separate publication on the tray system of growing mushrooms in Great Britain, by Fred C. Atkins, is also available from the Association (price 2*s*. 6*d*.).

Catalogue of Insecticides and Fungicides

The Murphy Chemical Co., Ltd., Wheathampstead, Herts, has issued an informative catalogue of insecticides and fungicides for the nurseryman and mushroom grower. Apart from descriptions of the firm's products, which include a wide range of substances in modern use, short technical information is given on pests, diseases, procedure and materials. A separate booklet outlines a complete spraying programme for the control of pests and diseases of mushrooms.

Planets and Sunspots

Dr. K. G. Meldahl has made some supplementary remarks concerning his predictions of sunspots during the early portion of this year (see *Nature*, **165**, 301; 1950). Eight drawings on his latest chart ("Tidal Forces in the Sun's Corona due to Planets", Part 2; Copenhagen: Berlinske Forlag) show the more important sunspots that he observed from January 18 to March 22, and he has a number of comments to make on these. The tidal force in the sun's corona this year was greater and of shorter duration than it was in 1938, and, as the configurations of the two inner planets were different in the two cases, a new field of inquiry appears to be opened up. It is pointed out that when the particles ejected by the sun cross the orbits of Mercury and Venus, if one or more of these planets happen to be in their path, they may suffer a certain amount of dissipation and reach the earth in diminished numbers. But if, as happened this year, these planets have moved a little to one side, the field being free from obstructions, the auroras will become more conspicuous, as they did during February of this year. These remarks are interesting for all who study sunspots and auroras, and observers of these phenomena may find important work in tracing the correlations between them and the planetary configurations.

Government Spending in Great Britain

In a recent number of *Planning* (PEP, 16 Queen Anne's Gate, London, S.W.1; 2*s*.) devoted to the subject of government spending, it is pointed out that in the present condition of the British economy there is no lack of claims on any increase of production which may be achieved. A continued increase of production, it had been hoped, would progressively relax the stresses of the present; but now greater defence expenditure may hinder the increase of production and will swallow up a part at least of whatever increase is achieved. A conflict of interests inevitably arises as between demands for increased personal consumption, greater industrial equipment and the expansion of certain social services. To some extent, the decisions must depend on judgment, and where there must be judgment there is room for dispute; there is, however, no point in arguing over matters of ascertainable fact. Planning decisions must be based on knowledge of the relevant facts; but at present the planning authorities lack this knowledge. The figures on government spending are not available in the most illuminating form; but the official statisticians have not attempted to provide a new classification, probably because of the nature of the records kept by government departments. This brochure by PEP suggests that the most practical course might be for the official statisticians to share the work with some of the universities. The lead, it is suggested, must come from the Civil Service, since the first step is the remodelling of the systems of accounting and recording in the various government departments.

Acta Argentina de Fisiologia y Fisiopatologia

The work recorded in the first issue of *Acta Argentina de Fisiologia y Fisiopatologia* (**1**, No. 1; pp. 291; Córdoba: Universidad Nacional, July 1950) covers a wide field. Edited by a committee of which Prof. A. Oriol i Anguera is the director, the journal begins with a paper by A. Cardin on the mechanism compensating the postural tone of animals (dogs) from which the cerebellum has been removed, the author claiming that his experiments have revealed two different innervations which influence the postural tone of the limbs, one passing through the cerebellum and the other through the mesencephalon. The next four papers record work by L. Legresti on the redox potential. They deal with its electrometric determination *in vivo* and *in vitro*, the potential in the blood and its reduction by certain substances; the same author contributes, with O. E. Semino, a further paper on this subject. M. C. Pérez records his experimental work, with details of his surgical methods, on the production of intestinal occlusion in dogs. R. D. Zunino contributes an article on the vaginal cytology of a human case of sterility, the study of which indicates, he claims, a relation between prolongation of the menstrual cycle and the administration of œstrogen. R. A. Sauchelli discusses renal physiology and pathology in guinea pigs whose ureters or renal arteries or veins have been unilaterally or bilaterally occluded. A longer paper by Prof. R. A. Brandán considers the climate of the mountains of Córdoba and its effects on certain diseases, and Prof. A. Oriol i Anguera discusses personality and endocrinology. The same author contributes a shorter paper on renal physio-pathology and notes on the Eighteenth International Congress of Physiology, held this year in Copenhagen. The journal is well printed; but the reproduction of its

illustrations leaves room for improvement in future issues.

Library Science Abstracts

THE first issue of a new quarterly journal, *Library Science Abstracts*, edited by Dr. C. B. Muriel Lock and Reginald Northwood Lock (1, No. 1, January–March; pp. 36; London: Library Association, 1950; 15*s.* a year), will be a disappointment to the scientific worker who may look to obtaining a summary of the latest papers on any particular science. The sub-title of the periodical is, however, more illuminating, for it reads, "A quarterly summary of articles of interest to Librarians and students of librarianship in the current periodical literature of the United Kingdom, the U.S.A., etc.". These abstracts will indeed be of service to professional librarians, and the need for such a publication is long overdue. Such periodicals as *Adult Education*, *Library World* and *Unesco Bulletin for Libraries* are covered by these abstracts, and subjects dealt with include public, hospital and special libraries, the art of the book, bibliography and bibliographies, and work with children.

Bibliography of Science in Latin America

CONTINUING the sequence in the bibliography of Latin-American scientific activities (see *Nature*, April 15, p. 589), the Field Science Co-operation Office for Latin America, in collaboration with various Ibero-American organizations, has issued three lists: scientific institutions in Brazil; scientific workers in Brazil; and scientific institutions of the Argentine ("Scientific Institutions and Scientists in Latin-America." Brazil: Vol. 1, pp. 139; Vol. 2, pp. 305. Argentina; Vol. 2, pp. 103. Montevideo: Unesco Centro de Cooperación Cientifica para América Latina, 1950). These volumes are more than directories. The two lists on institutions give the date of foundation of each institution, indicate its functions and field of work, and contain information concerning staff and publications, a full list of the latter being supplied for some of the entries. The other volume on Brazil also supplies much fuller information than would be given in, say, "American Men of Science", a list of publications being included besides particulars of occupation, career and experience, special field of work and details of membership of scientific societies.

Coryndon Memorial Museum, Nairobi

THE annual report for 1949 of the Coryndon Memorial Museum, Nairobi (pp. 21. Nairobi: Coryndon Memorial Museum, 1950. 1*s.*), records a notable year because at long last an appeal for funds to extend the Museum was launched officially. This is for £60,000, £50,000 of which will be used for buildings and £10,000 for equipment and furnishings. The Government of Kenya has generously agreed to give £5,000 towards the appeal and, in addition, to grant a further £1,000 for every £3,000 subscribed by the public. It is hoped that the full amount will be raised by 1952; but meanwhile the Trustees have decided that the first part of the building programme was to commence in 1950. This part of the extensions will include halls for entomology, botany, fish and reptiles, while the later part envisages halls for prehistoric and modern man and for geology and palæontology. It is pleasing to note that additional research rooms and storage space are included in the plans.

Announcements

PROF. W. T. ASTBURY, professor of biomolecular structure in the University of Leeds, Prof. Harold Jeffreys, Plumian professor of astronomy in the University of Cambridge, and Prof. N. V. Sidgwick, formerly professor of chemistry in the University of Oxford, have been elected honorary life members of the New York Academy of Sciences.

LIEUT-COLONEL FRANCIS J. GRIFFIN, general secretary and editor-in-chief of the Society of Chemical Industry, has been invested with the Ordre de la Couronne de Chêne (Order of the Oaken Crown) of Luxembourg for his services to that country during and since the War. Col. Griffin was for many years registrar of the Royal Entomological Society of London, and was intimately concerned with the formation of the Society for the Bibliography of Natural History in 1936, acting for ten years as its honorary secretary and editor. He has been organizer of three recent international scientific conferences.

THE National Research Council of Canada has announced the following new appointments in chemistry: Dr. Adrien Cambron, to be co-director, with Dr. E. W. R. Steacie, of the Division of Chemistry and director of the Applied Chemistry Branch, at the National Research Laboratories; Dr. Leo Marion to be assistant director of the Division of Chemistry and responsible, under Dr. Steacie, for the operation of the Pure Chemistry Branch.

DR. M. C. CHANG, of the Worcester Foundation for Experimental Biology, Shrewsbury, Massachusetts, has been appointed supervisor of the cattle ova transplantation programme of the Foundation of Applied Research, San Antonio, Texas. For more than eight years this Foundation, which is affiliated with the Southwest Research Institute at Essar Ranch, has been conducting research to enable low-grade cows to produce good-quality calves by acting as 'host mothers' to fertilized eggs transplanted from high-grade animals; so far pregnancies, but no births, have been obtained. Dr. Chang is a graduate of Tsing Hua University, Peking, and of the Universities of Edinburgh and Cambridge.

THE Institution of Naval Architects is offering during 1951 the following scholarships for naval architecture to British subjects (age limit shown in brackets), which, except where otherwise stated, are worth £175 a year and must be applied for before May 31, 1951: *Elgar* (23), for apprentices or pupils in the Royal dockyards or private shipyards (entries before January 15); *Trewent* (19), for apprentices or pupils in private shipyards; *Vickers-Armstrongs* (23), for apprentices or pupils in private shipyards (£220 a year); *Denny* (19), tenable for four years at the University of Glasgow, with apprenticeship of five years. There is a similar Denny scholarship in marine engineering. Further particulars can be obtained from the secretary of the Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1.

THE suggestion has been put forward that there is a need for a journal dealing entirely with the use and analysis of words and terminology in science and also in popular and even literary fields. It may be possible to start issuing a small mimeographed monthly or quarterly bulletin on this topic at the price of a shilling or two per copy to cover expenses; any suggestions or comments should be addressed to W. R. Dunlop, 57 Gordon Square, London, W.C.1.

TELECOMMUNICATIONS IN GREAT BRITAIN

IT has become almost traditional that, when an engineer-in-chief of the Post Office assumes office as president of the Institution of Electrical Engineers, he should give in his inaugural address a broad general review of the state of the telecommunications art in Great Britain.

The address of Sir Archibald Gill, delivered on October 5, dealt in the main with the telephone service. In his opening remarks Sir Archibald paid tribute to the work of Sir Thomas Purves in the development of the telephone service, and he referred at several stages in his address to the far-reaching decisions made by Sir Thomas in the early 1920's in regard to the form of automatic switching to be adopted by the Post Office and to the appraisal of these decisions in the light of the developments in the twenty-five years since they were taken. "Some of the newer systems," said Sir Archibald, "have particular advantages such as greater availability on their switches or speedier operation. None, however, has the simplicity and the universality of the step-by-step system, which allows the same components and the same circuits to be used in the smallest and the largest exchanges. Thus it is probable that if a similar decision had to be made to-day, the choice would be the same as it was twenty-five years ago. . . . Since 1945 teams of experts from this country have visited all the countries of the world where telephone development has been taking place. Much useful information has been acquired as a result of these visits, but nothing we have seen has suggested that the step-by-step system is obsolete or even obsolescent. . . . In fact, it is becoming obvious that there would be no gain now, and it is extremely doubtful whether there would be any gain in the future, in changing the present basic system for any other electro-mechanical system, and that the present system will meet all our needs satisfactorily until such time as something entirely novel appears, as, for example, an electronic system."

The possibility of developing an electronic switching system is, said Sir Archibald, "the subject of much interesting speculation by telephone engineers". A first step was taken towards the introduction of electronic switching equipment by the development of an electronic director which would perform the functions of the electro-mechanical director at present carrying out the routing of calls in large telephone-exchange areas. A two-digit electronic director has already been designed and tested, and field trials will be carried out under service conditions so that a direct comparison can be made of the performance of the electronic director with that of its electro-mechanical counterpart.

Referring to the progress of the change-over from manual to automatic switching, Sir Archibald stated that to-day 3·6 million stations are served by automatic exchanges, while about one and a half million are still served by manual exchanges.

The capital which has been invested in the local-distribution cables and lines connecting telephone subscribers to the central offices in Great Britain represents some forty per cent of the total capital value of the telephone system, and there is in consequence a strong incentive to effect economies in this item of telephone plant. One method of reducing the cost of local-distribution cable which has been practised extensively in other countries, particularly the United States, is that of connecting more than one subscriber to one pair of conductors. During recent years when it became necessary to give the utmost service with limited plant, the practice of shared service or party-line working was instituted in Great Britain, and some two hundred and thirty thousand subscribers are at present utilizing this service.

The lead-covered, paper-insulated cables at present used for local distribution are not free from disadvantageous features, among which is their vulnerability to mechanical damage and to chemical and electrolytic corrosion. Experiments are in progress on the use of the plastic polythene as an alternative insulant and sheath material for distribution cables.

In the matter of signalling by dial impulses in the telephone network, the development was initiated during the Second World War of dialling over the trunk network connecting the main centres of population. In the system now being used, signals are sent by currents of two frequencies, 600 and 750 c./s., transmitted over the speech circuit. "The present objective in the mechanisation of the inland trunk network is that a controlling operator situated at any trunk centre shall be able to complete a call to any subscriber connected to an automatic exchange anywhere in the country without the assistance of another operator. This will result in a considerable increase of tandem dialling over the trunk network, involving in some cases up to six links (four trunks and two local junctions) in tandem connected via the banks of switches."

A study group of the International Telephone Advisory Committee is engaged in examining the more complex problem of long-distance dialling over international circuits. It has been agreed among the administrations concerned to subject two schemes to practical trial on circuits inter-connecting London, Amsterdam, Brussels, Paris and Zurich. With the mechanization, not only of local-line switching but also of the trunk network, the familiar multiple switchboard with its rows of answering and calling jacks is now disappearing from trunk exchanges and is being replaced by a cordless type of switchboard in which cord circuits are replaced by key-controlled connecting circuits.

It is probably in the sphere of long-distance transmission that the most rapid advances have been made in recent years, the two notable developments mainly responsible being the negative-feedback amplifier and the co-axial cable. The reduction of intermodulation obtained by the application of negative feedback has rendered it "possible to contemplate putting large numbers of such amplifiers in tandem over long routes and to use them to amplify simultaneously a large number of telephone conversations spread over a wide frequency band extending upwards to a million or more cycles per second".

"The use of co-axial cable solved the problem of cross-talk, or transfer of energy by the coupling between different pairs of conductors, at these high frequencies; for, while it is practicable to produce cables containing twisted pairs in which the cross-talk is not excessive at frequencies up to 100 kc./s., it becomes increasingly difficult to do so at higher frequencies. On the other hand, the co-axial cable

behaves conversely; it has excessive cross-talk below about 50 kc./s. but improves rapidly at higher frequencies." The co-axial cable is essential for the transmission of television signals. For purposes of multi-channel telephony on co-axial cable systems, "the agreed international standard system is now 960 channels per pair in the frequency range 60–4,028 kc./s., using ⅜-in. co-axial cable with amplifiers at 10-kilometre intervals. . . . For television transmission over these ⅜-in. co-axial cables the Post Office is planning to use a vestigial-sideband system in which the video signal modulates a carrier of 1 Mc./s.: the upper sideband extending to 4 Mc./s. and a vestigial lower sideband extending down to 0·5 Mc./s. will be transmitted. This frequency transposition is necessary because the television signals extend to well below 50 c./s. and it is impracticable to send such frequencies over the co-axial cable because of cross-talk."

A four-tube co-axial cable was laid between London and Birmingham in 1936, and it was intended to use one pair of tubes for telephony and the other pair for television. The growth of traffic, however, brought both pairs into use for telephony and it became necessary after the War to plan an additional cable. "At the time when the design of the cable was being considered the Television Advisory Committee under the chairmanship of Lord Hankey had recommended in its report published in 1945 that the television service should be resumed using the pre-war 405-line system and that it should be extended to Birmingham and to other provincial centres, but that development of a higher definition system should be actively pursued. The report also visualized that the two systems would have to exist side by side for some time. The Post Office was thus faced with the possibility of having to provide, in the near future, transmission facilities for a system requiring a band-width of 10–20 Mc./s. As the new cable would occupy the sole remaining duct in the route, it was decided that at least one pair of conductors should be capable of carrying the highest definition television likely to be developed either in black-and-white or in colour." The new cable was therefore designed with two tubes of special construction having outer and inner conductors of 0·975 in. and 0·250 in. effective diameters. This cable has been manufactured and installed, and has been found to come well within the specification limits for impedance, uniformity and attenuation throughout the frequency range of 30 Mc./s. At 30 Mc./s. the attenuation of the special tubes is less than 9 db. per mile. The design of amplifiers and compensating networks for television links calls for work of the highest precision, "as the object is to attain a transmission standard which will ensure that the picture is not noticeably degraded after transmission over a distance, ultimately, of at least 500 miles". For the cable television link between Birmingham and Manchester "the gain of each amplifier at the maximum frequency (now 4·34 Mc./s.) is 52 db. and the system must be accurately compensated for phase-shift as well as gain/frequency response".

Sir Archibald prefaced his remarks on submarine cables with a reminder that this year marks the centenary of the laying of the first submarine cable across the Straits of Dover. The most important advance in recent years in relation to submarine cables has been the introduction of carrier working, as on land cables. "This has meant the development of improved dielectrics having lower losses at higher frequencies, and the adoption of the co-axial or concentric type of cable instead of the multi-core type . . . , the most important step in this direction has been the substitution of polythene for natural insulants." The other important advance has been the development of submerged repeaters to permit the use of higher frequencies. The first submerged amplifier in a Post Office submarine cable was laid in a co-axial cable between Anglesey and the Isle of Man. In 1946 a single amplifier was connected into the cable, 197 nautical miles long, from Lowestoft to Borkum, which had been laid to give direct telephone communication with Western Germany. The traffic-carrying capacity of this cable was thereby increased from one telephone and six telegraph circuits to five telephone circuits any one of which may be used to provide eighteen telegraph channels.

Further development has been directed towards designing a standard system for co-axial submarine cables of the lengths used on the Continental routes. This system, which provides sixty circuits per cable, was first used on the Aldeburgh–Domburg cables, the traffic capacity of which has been increased by a factor of five by the insertion, in each, of four submerged repeaters. The operational success of the submerged repeater is naturally dependent on the consistent longevity of its component parts, notably its thermionic valves. Considerable progress has been made in the production of small batches of valves with a predicted life in excess of five years.

In regard to the overseas radio-telephone services, difficulties are imposed by the limitation of the frequency spectrum available for these services. The most effective way of making the best use of this limited spectrum is by developing single-sideband multi-channel working, and considerable progress has been made with the conversion of circuits from double-sideband to single-sideband operation. "At the present time 38 circuits are being operated, of which 28 (including one of the two ship services) are obtained by single- or multi-channel operation on 12 single sideband senders. . . . The growth of traffic has been steady. On the eight London–New York circuits, the number of calls per week averages about 1,600 and is increasing at the rate of about 200 calls per week per annum."

Television programmes are transmitted, on carrier frequencies of the order of 900 Mc./s., from Alexandra Palace in London to the new television broadcasting station at Sutton Coldfield, Birmingham, by means of a chain of radio links which was brought into use in 1949. The extension of this service will be by co-axial cable to Manchester. From Manchester to Kirk o' Shotts near Edinburgh another chain of radio links will be employed. Two carrier frequencies in the region of 4,000 Mc./s. (7·5 cm.) will be used, and the transmission will be by frequency modulation with a deviation of about 7 Mc./s.

Two experimental demonstrations were given during the address. The first was of an equipment developed for the amplitude- and phase-equalization of the short cable links often used between the pick-up point and the control centre in television outside broadcasts. Equalization is effected by trial-and-error adjustment of the equalizer to restore the 'rectangular' form of 20-μ sec. pulses, of 0·1 μ sec. build-up time, transmitted over the line. The second demonstration was the transmission of a television test pattern from the Alexandra Palace studio over the double length of the new London–Birmingham co-axial cable to the lecture theatre of the Institution of Electrical Engineers. JAMES GREIG

ELECTRONICS SYMPOSIUM AND EXHIBITION

THE third electronics symposium organized by the Scientific Instrument Manufacturers Association was held in London during September 5–8. It followed the practice established last year in being accompanied by a compact, specialized exhibition of electronic instruments for use in research and industry.

The proceedings were officially opened by Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research; and the first address of the symposium was given by Prof. G. I. Finch, professor of applied physical chemistry, Imperial College of Science and Technology, London, who dealt with some industrial applications of electron optics. Prof. Finch pointed out that electron-optical methods have opened up wide new fields of experimental work for the study of surfaces and their properties. For the first time it has become possible to ascertain directly the nature of the atoms and their arrangement in surfaces, and also to map out surface texture to a detail approaching atomic dimensions. It would be difficult to exaggerate the importance to industrial problems of such a searching probe. Absorption, catalysis, crystal growth, adhesion, photo-electric and thermionic emission, mechanical wear and lubrication, corrosion and surface chemistry in general—all find their ultimate explanation in the atomic structure and texture of surfaces.

The succeeding sessions on September 6 were devoted to three papers on direct-current measuring and recording instruments. In the first, entitled "Recent Improvements in Direct Recording", W. Bamford (Everett, Edgcumbe and Co., Ltd.) described improvements in the driving movements of recorders in the directions of higher speeds of moving-coil elements, with better control of damping characteristics and the increase of facilities of the servo-operated types with their wide charts and multiple records. The limits of frequency response of direct recorders were discussed, and reference was made to a multi-pen pattern operated from a supersonic switching mechanism. Among marking devices, the improved ink-on-paper recorders and the latest details of electrical-discharge papers and their applications were described. The second paper was presented by R. Y. Parry and H. W. Finch (E. K. Cole, Ltd.) on the subject of the "Vibrating Reed Electrometer and its Application to the Measurement of Small Ionization Currents". This comprised a description of a simple vibrating condenser electrometer for measuring small direct currents and voltages under conditions of high impedance. The full-scale sensitivity of the instrument is 3×10^{-14} amp. or 30 mV., and fluctuations of the zero correspond to about 10^{-15} amp. or 1 mV. from day to day under normal laboratory conditions. This paper was followed by one entitled "A Review of Trends in *p*H-Meter Design", read by G. I. Hitchcox (Electronic Instruments, Ltd.), in which it was pointed out that the essential characteristics of any *p*H-meter are very high input resistance, stability and reliability under unusually severe industrial conditions. Further, it must be borne in mind that these instruments are usually operated by engineers from other fields, who may be unacquainted with electronics and often sceptical of the reliability of such apparatus. The paper concluded with a description of the practical difficulties which follow the use, for reasons of economy, of ordinary commercial components; and some means were suggested for overcoming or minimizing these difficulties.

The morning session of September 7 opened with a paper on "Some Aspects of Electronic Counting", by J. McG. Sowerby (Cinema-Television, Ltd.), in which a variety of electronic counter circuits was described beginning with a scale of two. It was shown how ring counters can be derived from the scale of two, and how counters of any scaling factor—including large prime numbers—may be constructed from more elementary circuits. Applications of these circuits to frequency division, the measurement of short time intervals, and the measurement of frequency were also described. This was followed by an interesting paper entitled "The Beta-Ray Thickness Gauge and its Industrial Applications" by G. Syke (Baldwin Instrument Co., Ltd.). The author referred to the fact that, in numerous industrial processes, it is essential to gauge the thickness or weight per unit area of sheets, strips and films, which may be moving at high speed. Radioactive isotopes from the atomic pile at Harwell emit ionizing radiations which are progressively absorbed, or attenuated, in passing through matter. The ratio of transmitted to incident radiation is a function of the quantity of matter traversed. This ratio can be accurately measured by simple electronic instruments, which are calibrated in terms of weight per unit area (gm./m.², mgm./cm.² or lb./sq. yd.) or directly in terms of thickness for any material of a given density. In addition, a balance indicator shows the deviation from a preset weight or thickness. The electrical output of the instrument is sufficient to drive recorders or servo-mechanisms for automatic process control. Applications to textile, paper, rubber, plastic, metal and other industries were described and illustrated. Trends of development, for example, gamma-rays for gauging heavy metals of considerable thickness, were indicated.

It was appropriate that the final paper of the symposium, given by J. K. Brimley (Nobel Division, Imperial Chemical Industries, Ltd.), should deal with the subject from the point of view of the user of instruments, and particularly in relation to the application of such instruments to industrial conditions. Mr. Brimley emphasized the fact that electronic instruments intended for use in industry must be designed for factory, and not laboratory, conditions; and it is important to bear in mind the actual physical conditions under which it will be necessary to use the instruments. There are also some considerable maintenance problems experienced by industrial users, for in many cases such maintenance has to be carried out by staff not possessing high technical qualifications. It is therefore essential that the greatest possible simplicity in design should be achieved, both from the electrical and the mechanical points of view. More rapid progress in the production of an instrument for some new application would, in general, be made if the designer and the user collaborated closely during the whole of the design stage.

In the exhibition some twenty member firms of the Scientific Instrument Manufacturers Association Electronics Group showed a variety of instruments and associated items; and it was evident from the display that scientific instrument manufacturers are continually extending and improving the applications of electronic techniques in instrumentation. A considerable field of application of electronic devices has

been opened up in connexion with methods of counting the fundamental particles of Nature, and in problems relating to radioactivity in general; several instruments for such purposes were exhibited. The widening needs of the radio engineer were also catered for in such items as standard-signal generators, field-intensity meters, valve voltmeters and oscillators of various types. The influence of television and frequency-modulation broadcasting has resulted in the production of a television sweep generator covering the frequency-range 40–190 Mc./s., a frequency-modulation receiver tester for the range 21–168 Mc./s., and also a carrier-deviation meter having a signal carrier range of 4–250 Mc./s., with deviation ranges of 0–5, 0–25 and 0–75 kc./s. The continued success and popularity of this symposium and exhibition should do much to assist the development and application of electronic techniques of all types.

THE BRITISH HAT AND ALLIED FELTMAKERS RESEARCH ASSOCIATION

By Dr. T. BARR
Director of Research

FELTMAKING as a textile industry preceded the manufacture of woven fabrics. In England, it has been an established craft for some centuries, with the Worshipful Company of the Art or Mistery of Feltmakers, a Livery Company of the City of London, controlling its destiny. This Company was granted its first Royal Charter in 1604; but records show that the industry was in existence for at least a hundred and fifty years prior to that date. With such a traditional background, there has been a natural reluctance to change. In addition to this aversion to change, the feltmaker, until recently, has closely guarded his secrets and processes from his neighbour, who was virtually his only competitor.

The pressure of outside events, however, has resulted in a revolution of ideas within the industry, culminating in the formation of the British Hat and Allied Feltmakers Research Association, the laboratories and headquarters of which at Stanley House, Fairfield, Manchester, were formally opened on September 19 by the Earl of Derby.

The change in the attitude of the industry which led to co-operation in the solving of its common problems was clearly expressed by Col. J. A. Christie-Miller (president of the British Felt Hat Manufacturers' Federation), who said: "As a result of two world wars, the opening of new factories in many countries, the installation of new machinery which is largely automatic and does not require skilled men to work it, and because of trade barriers and import restrictions, our competitors to-day are largely overseas." He pointed out that the industry's rough-and-ready methods are no longer adequate if it is to compete in world markets. It must make the fullest use of the scientific knowledge available and apply it to meet the specialized needs of the industry.

Attempts to form a research association for the hat and felt industry date back some thirty years; but it was not until 1943 that any real interest was displayed. Then the efforts made by a small research committee of the Worshipful Company of Feltmakers resulted in laying the foundations for the present organization. The response by firms engaged in the industry surprised even the sponsors of the scheme, whose hopes at the most were centred on securing enough funds to promote one or two research projects in existing laboratories. Once the benefits to be derived from the application of scientific methods in solving the long-standing technical problems of hat and felt manufacture had been appreciated, sufficient support was received from various branches of the industry and associated trades, and it was found possible to make immediate plans for establishing a felt research centre.

The Research Association was incorporated in February 1947, and recognized by the Department of Scientific and Industrial Research shortly after, being given the same status as other similar organizations with a substantial grant from Government funds, based on the income derived from the industry. In the same year, the first technical appointment was made, and the work of equipping laboratories and initiating a research programme was begun. Experimental work was started in 1948 in temporary quarters in the University of Leeds, where a laboratory was rented from the Department of Textile Industries. Although space was limited, the freedom to use the equipment and library facilities available at the University was of inestimable value in the early days of the Association while a permanent home was being found and equipped.

The research programme of the Association is decided and controlled by three research committees, representing the three main sections of the industry, producing wool felt, fur felt and hatters' fur respectively.

The initial programme took full cognizance of the fact that the industry, having developed by empiricism and reliance on rule-of-thumb methods, was lacking in quantitative methods of assessing progress. Therefore, the physical properties of felt are being studied in the hope that tests will be evolved as yardsticks for the trade. Arising from this study, a scheme for the quality control of felt has already been worked out which separates 'bulk' properties from 'fibre' properties. This scheme has found many applications and has provided members of the Association with the means of measuring changes in the quality of felt resulting from the modification of manufacturing procedure; and at the same time it has made it possible to determine whether or not the fibres from which the felt is manufactured have undergone any degradation during processing. In measuring the tensile properties of the felt, which forms an essential part of the scheme, it was discovered that the shape of the load-extension curves of the test samples is related to the previous history of the felt. The full significance of this discovery is demonstrated by the fact that it has repeatedly been used for solving 'blocking' problems of hat manufacturers.

The research projects also include studies such as that of the 'carrotting' process—the preparatory chemical treatment for rabbit and other furs, without which they lack the requisite properties for felt manufacture. A fundamental study of carrotting was begun in order to elucidate the chemistry of the reactions and the mechanism of the changed felting properties arising from the treatment. Considerable advances have already been made in this line of research, and

a better understanding has been reached of the chemical groups of the fur molecule which take part in the reaction. As a result, there is a prospect of the early development of a reliable test for the degree of carrotting of fur.

In the field of technological research, the staff of the Association is engaged in studying the different processes in the manufacture of felt from both wool and fur. Felting of these animal fibres is carried out in an acid medium, sulphuric and phosphoric acids being normally used for the purpose. Arising from work carried out by the Association in the industry, recommendations for the control of acid additions have been made and have been adopted with advantage by a number of member firms.

Further research projects of immediate benefit to the industry cover other processes such as dyeing and proofing. With the occupation of the new laboratories and the increase in staff thus made possible, widening of the scope of the programme is envisaged.

The building houses a chemistry laboratory; physics laboratory; dark room for optical and photographic work; and a testing laboratory for operations at controlled temperature and humidity. The addition of a technological block for carrying out small-scale industrial operations has been planned, and an early start on this project is expected.

Although the industry is not a large one and most of the firms are of the small 'family' type, it makes a useful contribution to the national economy. It is gratifying to note that the hatters' fur manufacturers, who supply the raw material for the fur felt section, are solidly in support of the research association, and that the majority of hat felt manufacturers in Great Britain are members, while manufacturers of machinery and dyestuffs and ancillary trades are strongly represented.

BATTERSEA LABORATORIES OF THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION

THE British Iron and Steel Research Association celebrated the third anniversary of the official opening of its Physics Laboratories at 140 Battersea Park Road, London, S.W.11, by holding 'open days' on November 9 and 10. The laboratories were originally opened by Lord Rayleigh on October 22, 1947 (see *Nature*, **160**, 684; 1947). The 'open days' were planned to indicate that during these three years a number of researches have led to results either having direct practical application in the steel industry or throwing light on the fundamental problems connected with iron- and steel-making and therefore of indirect value. The general plan of the Research Association under its director, Sir Charles Goodeve, is to have six Divisions (Iron Making, Steel Making, Steel Castings, Mechanical Working, Plant Engineering and Metallurgy) directly concerned with the six main groups of processes in the industry, and two Departments, Physics and Chemistry, which serve the requirements of all the six divisions. The laboratories at Battersea house the whole of the Physics Department (under M. W. Thring), a part of the Chemistry Department (under Dr. J. Pearson) and the Electrical Engineering Section of the Plant Engineering Division (under H. H. Mardon).

Physics Department

A booklet entitled "Physics in the Iron and Steel Industry" describes the work of the Battersea laboratories of the Research Association and also contains short accounts from seven big steel companies of the use of physics in their laboratories. These accounts show how the increase of efficiency and reduction of wastage in an industry causes a steady growth in the reliance upon accurate instruments for measurement, control and investigation of untoward occurrences. For this reason also, one of the five sections of the Physics Department is entirely devoted to the development of new instruments for the industry.

The physics of the various phenomena occurring in the manufacture and use of iron and steel provides the field for the work of the remaining four sections. It is clear that the present tendency among many physicists to regard the atomic nucleus as the only region of the universe which contains new and unrevealed general laws is far from justified, and much fundamental work of the greatest interest is being done already on the physics of the strength and plastic deformation of metals. Other phenomena of equal interest to the physicist are freezing and crystal growth under various types of cooling and with various impurities in the main element, the way in which atoms find their new positions in a transformation, the mixing of two fluids, heat transfer by convection from a gas jet, luminous radiation, the production of fine droplets by fluid impingement, the movement of a liquid under the impact of a gas jet, and splashing.

The following general ideas run through much of the work described: (1) the attempt to develop equipment for observing phenomena while they are occurring rather than relying on freezing them for subsequent study, and for probing inside complex systems to measure the physical conditions; (2) the application of methods of planning experiments which have been largely developed by the agriculturists to steel-industry investigations both in the laboratory and in the works; (3) the linking together of experiment and theory based on suitable simplifying assumptions; (4) the use of model techniques for studying systems of too great geometrical complexity for a fully mathematical treatment; (5) the application of physical techniques developed for quite other purposes to solve problems of the steel industry.

In the General Physics Section (J. Savage) the physics of the freezing of steel moving relative to a water-cooled mould surface has been intensively studied with the view of providing the fundamental background to the continuous casting of steel, a process which is just coming within the range of practical industrial operation. Measurements have been made of the friction between a 2½-in. diameter mould and the freezing metal, the heat transfer through the mould and the variations in surface quality at different rates of casting and different steel superheat temperatures. In this connexion, also, a vacuum apparatus incorporating an Andrade balance has been built to study the plastic flow of steel at temperatures between the A_3 point and the melting point. The flow-rate has so far been evaluated for one steel from 950° to 1,400° C. over a range of stress of 80–280 kgm./cm.^{2}. This Section has also applied the Geiger counter to the X-ray diffraction observation of transformations in steel while they occur, and to fluorescence analysis, and has developed a high-magnification, high-temperature microscope.

The Instrument Section (S. S. Carlisle) has developed two instruments which are already in use in the industry, a sensitive differential pressure meter giving an electrical signal suitable for remote indication and automatic control of furnace pressures, and a wire-drawing die profilometer which enables the wear on a die to be observed to very fine limits. A fully automatic instrument is now in the laboratory. Two other interesting applications of physical principles are the meters which measure the width of a 16-in. strip with an accuracy of 0·01 in. although the strip moves laterally by 0·125 in., and the thickness of steel plates from one side by measuring the magnetic saturation flux density.

The Heat and Thermodynamics Section (R. Mayorcas) has worked on the measurement of temperature and radiation from liquid and solid steel, the inside surface of furnace walls and gases. Methods of measuring surface temperatures have been developed which avoid errors due to variations in surface emissivity by the use of reflecting caps, while a neat and compact furnace gives a source of radiation, 3 in. diameter and up to 1,750° C., which is very nearly a full radiator. A calorimeter instrument measures the sensible heat content of flame gases for the construction of partial heat balances. The Section has also taken a considerable part in the flame radiation trials carried out in Holland jointly with Dutch and French scientific workers (see *Nature*, August 12, p. 255).

Rather more than half the work of the Aerodynamics Section (M. P. Newby) has been devoted to problems of gas and air flow, mixing and impingement on refractories in the open-hearth furnace. The flow resistances and flow patterns have been studied with cold-air models and on a full-scale furnace operated with cold air, and a special technique has been developed for measuring mixing patterns by the use of carbon dioxide and methane as tracers the presence of which is detected by the infra-red gas analyser. A new type of Pitot tube giving a relatively high Reynolds number for a low velocity has been developed for use in furnaces; the shape of orifices to give a constant coefficient at low Reynolds numbers and the flow of gas and steel in the sideblown converter have been studied.

The Mathematics Section (H. Herne) devotes about equal fractions of its energies to the attempt to provide a theoretical background to experimental work in the British Iron and Steel Research Association and to statistical design of experiments and evaluation of results. The blast furnace and the open-hearth furnace have been studied in both ways; in the former case the theory relates to the heat balance in stages, and in the open-hearth furnace to the details of heat transfer. A six-variable two-level factorial trial has been planned for an open-hearth furnace and executed by a steelworks, giving significant results for five of the variables. The solidification and stresses in castings have been calculated by numerical means. Another interesting theoretical study relates to traffic analysis in steelworks and ore-handling ports.

Chemistry Department

The work carried out in the laboratories (under J. H. E. Jeffes) at Battersea which form part of the Chemistry Department is mainly fundamental research work on the physical chemistry of the processes which are used in the iron- and steel-making industry. At the present moment researches are in progress on the following topics: (1) the rate and mechanism of the reduction by hydrogen of thin films of iron oxides on pure iron; (2) the equilibrium conditions of phosphorus in solution in liquid iron in contact with a solid lime and tetracalcium-phosphate pair at various oxygen potentials; (3) the partition of sulphur between gas and slags under various conditions of slag composition and oxygen potential; (4) the stabilities of various sulphides at high temperatures using radioactive sulphur; (5) the heats of formation and high-temperature heat contents of slag components; (6) the construction of a vacuum fusion apparatus for the determination of gaseous substances dissolved in steel samples, etc.

Plant Engineering Division

A control device has been developed for application to a hot-strip mill in order to compensate for the increase in finished thickness which occurs from front to back of a long strip of steel. The screwdown motors in a tandem mill are operated intermittently according to a preset programme based on previous strip measurements. All presetting and control is effected at a power-level consistent with the use of standard post-office equipment, resulting in compactness, cheapness and reliability.

Another strip gauge control, originating with the Mechanical Working Division, uses the mill itself to measure the strip thickness and modulates reel tension as the output signal. The Plant Engineering Division has devised the closed loop, and it is shown that the output is expressible as a sixth-order differential equation.

A novel method for cleaning industrial gases, such as blast furnace gas or flue gas, uses water sprays of a controlled size thrown from the periphery of a series of rapidly rotating disks arranged in the centre of the pipe along which the dirty gas is passed. This gives a high degree of dust removal with the minimum expenditure of energy and water.

A small-scale cleaner having a capacity of 6,000 cu. ft./hr. mounted in a mobile laboratory truck for convenience in doing trials at steelworks, and a larger unit to treat 100,000 cu. ft./hr., were on view. In the latter machine the five disks of 16 in. diameter are rotated at 5,000 r.p.m. by a 2-h.p. steam turbine. The water drops have an initial speed of 300 ft./sec. and a size of 100 microns. This dense mist of drops is thrown across the dirty gas stream as it passes through an annular space surrounding the disks. The machine is about to be installed in a steelworks for trial under production conditions.

Dynamic stresses in gantry girders such as occur when a crane picks up a heavy load are being studied with strain gauges. Steelworks crane cabs are being improved in several ways; for example, master controllers have been completely redesigned to give near spacing. These now have vertical handles moved radially instead of the 'tramway' controller motion usually adopted, and maintenance inspection and replacement of contact assemblies can be made without detaching any wiring from the controllers. The driver will be seated in a special seat based on one designed for the Admiralty to ergonomic principles by the Department of Human Anatomy, Oxford, and Messrs. Fairey Marine, Ltd., and the controllers will be grouped around the driver for optimum ease and accuracy of working. The new controllers and cab lay-outs will be in line with the new specification of the British Iron and Steel Research Association for heavy-duty electric overhead cranes.

A rotary chart translator enables a large number of circular charts to be re-recorded on a single strip chart with a reduced time base to facilitate a detailed study of blast-furnace blowing requirements. A 48-way recorder enables temperatures at different points in ingot moulds after teeming to be studied.

TECHNICAL BOOKS AND INFORMATION

THE Scottish Branch of Aslib held a conference in the Mitchell Library, Glasgow, on October 6. The conference was opened by Mr. C. A. Oakley, who spoke on this occasion as the author of several technical books, and not in his official capacity as regional controller for Scotland of the Board of Trade. He regretted that Glasgow has a reputation as a 'tough' city, largely due to certain books written about it, and said that he had written "The Second City" in answer. Mr. Oakley went on to suggest that this unsavoury reputation is a factor in the problem of bringing new industries to Scotland. There is no difficulty in persuading managers to come and live in the Glasgow area; but the charge-hand type of worker has taken his idea of the city from news and books. Describing his own experience, Mr. Oakley said that too frequently an author of technical books has to meet the cost of publication, and it is rare that this type of book produces substantial royalties. It may take ten years to collect the material, and technical books are better if they are written slowly over a period of years rather than tackled and finished in a few months.

Mr. James Fergusson, Keeper of the Records of Scotland, outlined the history and care of the records of Scotland and stressed that the live, active interest of the people is necessary to solve the problems facing Register House.

Sir James French, speaking on "Books in Industry", said that books should be available for self-education, and advocated numerous well-distributed collections of technical works. He suggested that money for this would be well spent, and could well be saved by reducing the school-leaving age to thirteen. His experience over many years has proved that youths at thirteen are ready and willing to leave school, and gain more from an earlier apprenticeship to a trade than from an enforced attendance at school, which bores them and wastes their time. Sir James said that even the most modern books are in some degree historical and that "pioneers of industry spend their lives hunting in unknown forests for which there are no guide books, until they themselves may write them".

The next speaker, Mr. W. A. Beck, superintendent for Scotland of H.M. Stationery Office, outlined the publications available and described the various classes of papers published. The last paper, by Mr. S. Weinberg, research manager of Messrs. G. and J. Weir, Ltd., was on "The Attitude of the Research Worker to Technical Information". He quoted Sir Alfred Egerton, giving the present rate of publication of scientific papers as approximately one million, ninety per cent of which are only written to publicize their author's existence. There is no easy solution, because a publication giving arbitrary results might well have a value in the experimental techniques described. Too often the librarian regards the research worker as an individual pursuing a certain line of inquiry for a particular project. Ninety per cent of his reading time must be allocated for routine 'keeping abreast', but reading time for a specialized job cannot be arbitrarily decided. Mr. Weinberg said that it is useless for the research worker to attempt to examine more than one-tenth of one per cent of published material, which works out at twenty to twenty-five papers or articles a week. Of these, one-tenth may be of immediate interest, and a fraction of wider interest. In this connexion, it was stressed that editors cannot pay too much attention to the 'contents' page. Selection of material should always be the responsibility of the research worker and should not be left to the librarian, although the latter can usefully do the routine work of abstracting after the initial selection. From experience, Mr. Weinberg regretted that the emphasis in abstracts is on results, which are often of less use than the operational techniques and the experimental results prior to analysis.

Mr. Weinberg put forward a plea for discrimination on the part of editors and secretaries of learned societies, and he hoped that the advantages of personal publicity would be reduced in such a manner as to discourage all but the better papers. Repetition should either be avoided or clearly indicated. Until it is possible to dial the number of the information required and see it flashed on a screen, the bringing together of the librarian and research worker on a personal basis is most likely at this stage to produce beneficial results.

MILK RECORDING AND BREEDING OF DAIRY CATTLE

SINCE most of the important statutory activities of the Milk Marketing Board were taken over by the Ministry of Food at the beginning of the Second World War, and have not yet been restored to it, a good deal of the energies and the not inconsiderable financial resources of the Board have been of recent years devoted to the milk recording and breeding movement, with the ultimate objective of improving milk yields per cow and also milk quality. Dr. Joseph Edwards, head of the Production Division of the Milk Marketing Board, in an address to the Farmers' Club at a meeting in London on October 2, gave a valuable account of the extensive progress made in three fields: milk recording (National Milk Records) since the Milk Marketing Board took over this scheme from the Ministry of Agriculture in 1943; the development since 1947 of the Milk Marketing Board Bureau of Records; and artificial insemination of dairy cows which, following the pioneer work started in 1942 at the experimental centres at Cambridge and Reading, was taken up on a commercial scale by the Board in 1945.

In the first of these fields, the number of recorded herds has gone up from just over 4,000 to more than 24,000; about twenty per cent of the dairy cows in England and Wales are now recorded for yield. Some progress has also been made in recording butterfat percentage; about seven per cent of dairy cows are now in the scheme. All recorded cows are identified by ear-marking, itself no inconsiderable task. As regards development since 1947 of the Bureau of Records, this Bureau publishes annually a report and analysis of the figures obtained from the National Milk Records, a publication of real value to most of

the organizations and individuals interested in herd improvement; it also provides statistical and other services for artificial insemination centres and collates much data for the various breed societies and others. In the field of artificial insemination the progress has been particularly striking. The number of cows artificially inseminated from Milk Marketing Board centres has risen from 6,401 in 1945–46 to no less than 431,402 in 1949–50. In non-Board centres the number inseminated in the latter year was 172,321, so that the total for the country is well over 600,000, that is, some twenty per cent of the dairy cattle in England and Wales are now served artificially by bulls of which the great majority are well above average quality.

The records quoted by Dr. Edwards show the rapid advance in numbers in recent years of the heavy-yielding Friesian (or Friesian-type) animals, which now form as much as 32 per cent of the total national herd. He also gave some interesting figures indicating fluctuations in herd fertility (disclosed by artificial insemination).

From Dr. Edwards's figures and conclusions, which are borne out by all recent experience, it is clear that, at present, the main limiting factor in milk production in many herds is not heredity but dairy farming technique, particularly in relation to grassland improvement and pasture management.

H. D. KAY

FILMS AND FILMSTRIPS IN FUNDAMENTAL EDUCATION

PRODUCED in collaboration with Unesco, four new educational pamphlets of Film Centre, Ltd., discuss the role of films and filmstrips in fundamental education. The first, "The Film and Fundamental Education", shows that the full development of the film in fundamental education must depend to a large extent on governments. The finance and the resources involved are considerable, particularly for production. But whatever the contribution made by governments, a very large measure of initiative still lies with non-official organizations of all kinds, especially in the field of film use.

In many areas where the population is scattered, mobile units are likely to remain the most effective means of showing films for some time to come. Since the equipment of a mobile unit costs several thousand pounds, the responsibility will continue to lie mainly with governments. Ultimately, however, mobile units must make way for static projectors in each community, if films are to gain a regular and accepted place in local life. At this point private organizations should be ready to play their part. Where an individual organization is unable to afford the cost of a projector, a co-operative film service, uniting a number of bodies or persons prepared to contribute, can provide projection equipment and skilled projectionists. The service is also capable of further extension to include training courses for its members, and even a film lending library service.

In this context the Film Councils, developed in Canada and the United States, provide a very relevant example. These Councils bring together local bodies of all kinds—youth clubs, women's institutes, churches, chambers of commerce, trade unions, industrial firms, farmers' groups and others—for a common purpose, to promote the educational use of the film. The Ottawa Film Council, for example, has more than a hundred affiliated organizations. The main value of the Council is twofold. By the pooling of finances the resources available to the community can be very considerably increased. The fullest possible local participation is also ensured.

Popular initiative and use of co-operative methods are, in fact, the keys to success. In the last analysis, fundamental education can only be a living and creative movement if it is a movement of the people themselves, working together for the advancement of the whole community and with it the whole nation.

The second pamphlet describes the most suitable apparatus for the projection of films and filmstrips in fundamental education, while the third and fourth pamphlets deal with the choice and care of films and filmstrip in fundamental education.

ACCEPTANCE SAMPLING

AT the first post-war meeting of the American Statistical Association, held in Cleveland, Ohio, in January 1946, an all-day session was devoted to statistical methods of acceptance inspection, and the proceedings of this session have recently been published*. It is a pity that there has been more than four years delay in publishing this material, as its prompt appearance would have had a stimulating and clarifying effect. As it is, considerable further development of the subject has occurred, and the book is somewhat out of date. A good deal of it will make worthwhile reading, nevertheless, to anyone interested in industrial inspection.

The first half of the book is devoted to acceptance sampling by attributes. A short history of developments prior to 1941, by Paul Peach, is well written and good, except that no reference is made to British work (one has to admit, however, that not much British work had been published). E. G. Olds, in a review of war-time developments, gives clear descriptions of the various methods available (though the relations between them are not always shown up well) and has compiled a good bibliography. Then follows the most interesting feature of the book, a verbatim report of a long discussion on sampling by attributes. The seventeen contributors appear to speak from extensive experience and to have really thought about the subject; and their discussion is remarkably shrewd and to the point.

The second half of the book, devoted to acceptance sampling by variables, is less interesting. J. H. Curtiss applies the language of the Neyman–Pearson theory of testing hypotheses to deal with a limited range of problems arising with specifications of population mean. A short summary is given of a paper by W. A. Wallis on using measured values of a variable to estimate the proportion falling beyond some limit and classed as "defective", instead of merely noting the proportion of defectives directly; a full account has been published in "Selected Techniques of Statistical Analysis" (London: McGraw-Hill Publishing Co., Ltd., 1947). The ensuing discussion on sampling by variables, though it brings out some interesting points, rather flags by comparison with the first discussion. J. W. Tukey, as chairman, gives a good summing-up.

F. J. ANSCOMBE

* Acceptance Sampling: a Series of Papers and Discussion on the subject of Acceptance Sampling delivered at the 105th Annual Meeting of the American Statistical Association at Cleveland, Ohio, on January 27, 1946. Pp. iv+155. (Washington, D.C.: American Statistical Association, 1950.)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Immersion and Survival in Cold Water

A SURVEY of the results of experiments performed in baths[1] suggests that few men would live in water near freezing point for more than 30 min. and none for more than 1½ hr. Yet some people derive much pleasure and no harm from brief immersions in such water, and shipwrecked people are known to have survived after spending several hours in icy seas. Thus, Molnar[1] has quoted a group of twenty-three people who all survived long immersion in the sea although experiments performed in baths suggested that this should have lowered their rectal temperatures to 24° C., and he was surprised to find in another report that three men who had no life-jackets could hold up their heads after 1 hr. in water at 4–7° C. Critchley[2], moreover, has quoted an example of a man who survived after swimming for more than half a day in water at − 1·5° C. The following observations and calculations may explain this apparent contradiction.

All tests were performed on one subject aged thirty-six years, 180 cm. high, and weighing 85 kgm., who was a moderate swimmer and unaccustomed to cold water. The calculations apply to a man of his size. He first swam for about half a minute in an arctic sea inlet at a water temperature of 3° C. When he came out of the water his skin temperature was only slightly lower than it had been before, and it returned to near its original level within 10 min. although he was not artificially warmed. His rectal temperature rose by 0·4° C. immediately after the swim; this was probably caused by a mechanism which has been discussed elsewhere[3].

It can be calculated how fast this subject was losing heat in the cold water if it is assumed that his surface area[4] was 2·05 m.², the average conductivity of his superficial tissues between 9 and 10 Cal./m.²/hr./° C.[5–7] and the temperature of his deeper tissues near 37° C. (though it cannot be said exactly what the latter was[3]). At water temperatures of 0–5° C., this man should have lost some 12·5–10 Cal./min. Since his specific heat was probably 0·83[8], this rate of loss would have lowered his average body temperature by about 0·18–0·14° C./min. It is clear, therefore, that immersions of a few minutes in very cold water cannot cool the body to a dangerous extent.

Experiments have since been performed to study the heat production during swimming. They were done at water temperatures of 20° C. and air temperatures of 15–20° C. The subject swam with a Douglas bag on his back. Samples of expired air were analysed in Haldane's apparatus[9] and the heat production was calculated from the oxygen consumption. The results are given in the accompanying table. If the subject had been swimming in colder water his heat production would have been at a similar level, because it is evident from Spealman's data[10] that in the absence of shivering the heat production of a subject immersed in water does not depend on the water temperature. Even if the actual heat losses were a little higher than those calculated above[11], a man who is swimming hard should produce about as much heat as he loses in water near freezing point, and he should not die of cold as long as he is able to swim. Stiffness of the muscles may eventually interfere with efficient swimming; but muscles which are being exercised hard may remain warm enough to prevent them from becoming stiff. After rescue, moreover, a man who has been swimming would not require to warm his limbs at the expense of more important regions of his body[3], and he would continue to have a high level of heat production for some time. This may be a great help in resuscitation. Men in baths may shiver, but only after they have lost much heat, and they cannot produce enough heat by this means alone to balance their losses in very cold water[11].

HEAT PRODUCTION WHILE SWIMMING

Activity before collection	Activity during collection	Period of collection (min.)	Heat production Cal./min.	Heat production Cal./m.²/hr.
Squatting near pool	Slow swimming	1	8	234
Squatting near pool	Slow swimming	2	10·5	307
Slow swimming	'Treading water'	1	7·5	220
Moderately hard swimming	Moderately hard swimming	1	12·5	365
Slow swimming	Squatting near pool	2	4·5	134
Lying still	Lying still (basal metabolic rate)	12	1·2	34·1

Fit men, therefore, who are in danger of immersion in cold water, might be advised to swim or struggle as hard as they can for as long as they can. If they try to preserve their strength by clinging to wreckage or floating on their lifebelts, they will die from cold. Perhaps more lives would have been saved in the past if this had been understood.

My thanks are due to Prof. R. A. McCance for his interest and help, to the captain of H.M.S. *Truelove* (Cdr. A. S. Jackson, R.N.) for allowing the arctic experiment to be conducted from his ship, to the Master and Fellows of Emmanuel College, Cambridge, for the use of their swimming pool, and to Surg. Lieut. G. R. Hervey, R.N.V.R., for determining the metabolic rates.

E. M. GLASER

Medical Research Council
Department of Experimental Medicine,
Cambridge. Aug. 9.

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Comparison of Archæological and Radiocarbon Datings

SEEING that the radioactive carbon method for dating the past so lucidly described by Prof. F. E. Zeuner in *Nature* of November 4, p. 755, was evolved primarily to test certain physical hypotheses, it may be of interest to physicists to see how far the applica-

tion of the method to materials relatively or absolutely dated by archæological methods yields consistent or confirmatory results. More than five hundred radiocarbon dates have now been published[1]. Attached to each is the standard deviation, "consisting solely of the error of counting random events". These dates include seven objects from Egypt and five from northern Europe, at least the relative ages of which are well established by archæological methods.

EGYPT

Object No.	Archæological period or site	Historical age in years before present	Radiocarbon dates	Average	Average B.C. dates
62	Ptolemaic (coffin wood)	2280	2199±450		240
81	Sesostris III (tomb)	3750	3845±400 3407±500 3642±310	3621	1671
12	Sneferu (tomb)	4575±75	4721±500 4186±500 5548±500 4817±240	4802	2852
1	Zoser (tomb)	4650±75	3699±770 4234±600 3991±500	3979	2029
267	Udimu (Hemaka's tomb)	4900±150	4803±260 4961±240	4883	2933
463	El Omari (? Neolithic)		5256±230		3306
457	Fayum A (Neolithic)		6054±330 6136±320	6095	4145

The very wide discrepancies in the estimated age of the same object in the cases of objects 1 and 12 will be at once noticed; but it should be remembered that these are among the earliest experiments. The radiocarbon date for the roof beam of the tomb of Hemaka, vizier of the fifth Pharaoh of the First Dynasty, favours the higher of the historically possible dates for the unification of Egypt under "Menes". While the settlement at El Omari is still formally neolithic, it was occupied for a considerable time and might well be regarded as later than the Fayum neolithic (Object 457), though surely substantially earlier than the foundation of the First Dynasty.

NORTHERN EUROPE

Object No.	Archæological period or site	Radiocarbon dates	Average	Average B.C. dates
	Neolithic			
462	Ehenside Tarn (wood)	4964±300		3014
	Mesolithic			
434	Boreal, Zone VI* (Aamose, charcoal)	8631±540		6681
433	Boreal, Zone VI (Aamose, hazelnuts)	9935±440 9927±830	9929	7979
432	Boreal, Zone V (Aamose, pine cones)	7583±380		5633
353	Pre-Boreal, Zone IV (Starr Carr, wood)	10167±560 8808±490	9488	7538

* The sequence of zones, defined by pollen analysis, has been established stratigraphically by Prof. K. Jessen and Prof. H. Godwin.

Britons will be pleasantly surprised to find that a full neolithic settlement in Cumberland, which on archæological grounds should certainly be later than the first neolithic sites of southern England, should be so ancient. The discrepancy between 433 and 434, hazel-nuts and charcoal respectively, from the same temporary camping place on Aamose in Zealand, may disclose a serious methodological defect. The date for 432 is so discordant with 433 and 353 as to suggest that the samples have got mixed up. On archæological and palæobotanical grounds, the wooden platform on the edge of the former Pickering Lake in Yorkshire excavated by Dr. Grahame Clark must be substantially older than the foregoing Danish sites (432–34). The discrepancy between the results obtained from two pieces of wood from this platform is alarming; but the average happens to agree rather well with the estimates of the age of the climatic phase and pollen zone to which, based upon the geochronological method of de Geer, it belongs.

In conclusion, it might be noted that if object 75 represents, as appears, the date for the beginning of agriculture in the Chicama valley of Peru, that would have happened 2,300 years later than in Cumberland. But a mere archæologist feels that the method will require considerable checking and refinement before it can provide reliable dates for prehistoric events.

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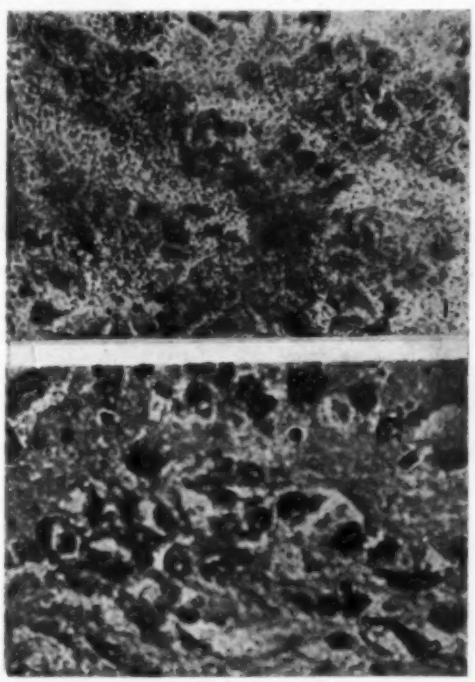
Autoradiographic Evidence for the Occurrence of Organic Iodine in the Anterior Lobe of the Pituitary Gland

USING sodium iodide labelled with iodine-131 (supplied by the Atomic Energy Research Establishment, Harwell), we have studied by the autoradiographic technique the distribution of iodine tracer doses in the pituitary gland of the guinea pig.



Photomicrograph of the pituitary gland of adult guinea pig, with autoradiographs superposed. The reduced silver grains are present only in the anterior lobe (Fig. 1), and are completely absent in the posterior lobe (Fig. 2). × 395

Each of a group of adult animals was injected with a single dose of 0·3 γ of iodine (corresponding to the quantity contained in the animal's normal daily food), containing 250 c. C. of iodine-131. The animals were killed after 24 hr. and the pituitary and thyroid glands removed. These were embedded in paraffin, and then histological sections of thickness 2–5 μ were prepared, mounted on microscope slides, covered with Kodak stripping emulsion for autoradiography and exposed[1].

The thyroid sections were exposed for 18–24 hr., and in the resulting radiographs the occurrence and distribution of iodine were in complete accord with the findings of other authors[2]. These radiographs served as controls on the quality of the emulsion and the method of development, and at the same time acted as checks on the observations on the pituitary.

The pituitary sections were found to be only weakly active and in consequence were exposed for the maximum time advisable, that is, about three half-lives (21 days); after this time the plates were developed and then stained with Hæmatoxylin and Eosin. Under the microscope, it was possible to see a weak impression in the emulsion corresponding to the anterior lobe of the gland and its pars tuberalis; but there was no evidence for the presence of iodine in the posterior lobe. Fig. 1 shows a portion of the anterior lobe and Fig. 2 a portion of the posterior lobe, on which the corresponding autoradiographs are superposed.

Since the iodine fixed selectively in the anterior lobe is in organic form—as is shown by the fact that it is not soluble in the liquids normally used in the preparation of histological sections[3]—we think that our observations confirm the statement of Sturm and Schneeberg, and of Joliot and co-workers[4] on the property of the pituitary gland of fixing thyroxine in a specific manner. The present result, however, seems to demonstrate the direct influence of the thyroid on the anterior pituitary.

Work on this subject is still in progress and will be reported fully elsewhere.

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Surface Structure of Feathers from the White Domestic Fowl

The cuticle of an animal fibre consists of a thin membrane, the epicuticle[1], covering the surface, and at least two more layers, the exo- and endo-cuticle[2]. The epicuticle of wool has been especially studied at this Institute, and work is now being carried out on its fine structure and chemical composition. Related subjects such as the feather vane and down from the white domestic fowl have also been examined in the electron microscope in order to see if any corresponding layers could be found.

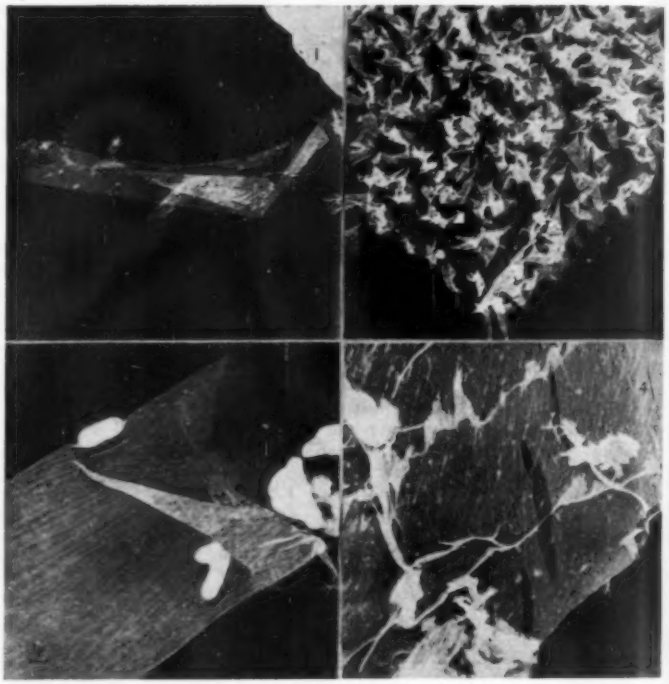

Fig. 1. Fragmented membrane obtained by bromination of feather vane followed by shaking with water. Palladium shadowing, 4 to 1

Fig. 2. Membrane covered with sacs, from tryptic digest of phenol-treated feather vane. Palladium shadowing, 4 to 1

Fig. 3. Tube-like striated membrane from tryptic digest of phenol-treated feather down. Palladium shadowing, 4 to 1

Fig. 4. Double striated membrane from alcohol-bisulphite dissolved feather vane. Palladium shadowing, 4 to 1

The chemical and enzymatic treatments of the feather specimens were essentially the same as those earlier used for wool[3]. After a slight bromination followed by shaking with water, the membranes shown in Fig. 1 were found in the suspension. They resembled very much the epicuticle isolated from wool in a similar manner. However, these membranes seemed to be more brittle and did not occur in such large pieces as in the case of wool. The thickness was slightly less than 100 A.

Phenolic treatment (50 per cent phenol in water, 2 hr. at 100° C.) followed by digestion with trypsin[4] produced big pieces of thin membranes, some of them completely covered with small sacs of the cornet-like shape shown in Fig. 2. These sacs give a velvet-like appearance to the surface of the barb

and might be helpful in increasing the water-repellency properties, and also in reducing the mobility of air within the feathers for heat insulation and during flight. In the same specimen were also found sheaths showing striations which gave the impression of a replica of bundles of microfibrils. This can be seen in Fig. 3, which is from a preparation containing only downy barbules. The thickness of the membranes from the phenolic treatment varied between 50 and 200 A. Similar results were obtained by dissolving the feather parts in dilute sodium sulphide.

Thicker sheaths, up to 0·1 micron in thickness, were obtained when feather barbs were dissolved in 50 per cent alcohol to which had been added some 0·1 per cent sodium bisulphite[4]. These membranes were mostly double (originating from both sides of the barbules), and in the optical microscope it could be seen that they still retained the contours of the original feather parts. In the electron microscope, marked striations and also compact ridges could be observed. These ridges might belong to cell walls (Fig. 4).

The treatment with phenol and enzyme or with alcohol and bisulphite leaves only the outer parts of the feather vane and down undissolved. From the different action of the reagents it can be concluded that the keratinous body is enveloped by a cuticular sheath approximately 0·1 micron thick, consisting of at least two layers. The external of these, practically unattacked by tryptic digestion, is the same as that freed by bromination. It is the most resistant one and is analogous to the epicuticle of wool. Beneath there is the second layer, which is digestible by trypsin but unattacked by alcohol and bisulphite. This layer might correspond to the exocuticle of wool.

Further details of this investigation will be published elsewhere. These studies of the epicuticle have been aided by a research studentship to one of us (G. L.) from the International Wool Secretariat.

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Superconductivity of Tin Isotopes

Measurements have been made of the superconducting transition temperatures and critical fields of nearly pure tin isotopes separated by the electromagnetic method; the mean atomic weights provisionally determined by mass spectrograph were $116{\cdot}2 \pm 0{\cdot}2$, $120{\cdot}0 \pm 0{\cdot}2$ and $123{\cdot}6 \pm 0{\cdot}4$. Samples of about 15 mgm. in the form of cylinders 1 cm. long cast in silica tubes were used, and transitions were studied (*a*) by observing the magnetic moment in a constant small magnetic field (2 gauss) as the temperature was lowered, and (*b*) by measuring magnetization curves at constant temperatures. The magnetic moments were measured by a ballistic method[1], and to improve relative accuracy all three samples were studied together. The transitions were sharp ($\sim 0{\cdot}01°$ K. width), and the transition temperatures (T_c), defined as the temperatures (extrapolated to zero field) at which the ratio of magnetic moment to field had half its superconducting value, could be determined with a precision of order 0·001° K. relative to each other. The values of T_c expressed on the 1949 scale[2] were:

M	116·2	120·0	123·6
T_c° K.	3·763	3·707	3·654

Maxwell's[3] value $T_c = 3{\cdot}662°$ K. for an enriched sample with $M = 123{\cdot}1$ lies well on a graph of these results, and so too does the value $T_c = 3{\cdot}726°$ K. for natural tin[4] ($M = 118{\cdot}7$). A log–log plot shows that our results are consistent with the relation $T_c \propto 1/M^{1/2}$, but until the atomic weights have been determined more precisely, a departure of the exponent by as much as 0·05 from $\frac{1}{2}$ is not excluded. This relation was predicted by the theories of Fröhlich[5] and Bardeen[6], and has already been verified in experiments on mercury isotopes[7,8]. By direct measurements of differences (ΔH_c) of critical field (H_c) between two isotopes at the same temperature, it was established that the H_c—T curves are geometrically similar; in particular, the value of $\Delta H_c/H_c$ extrapolated to 0° K. was found equal within 5 per cent to $\Delta T_c/T_c$, so that the relative change of electronic specific heat cannot exceed 5 per cent of the relative change of mass. The value of dH_c/dT at $T = T_c$ was 142 gauss/° K., and the value of H_c/T_c extrapolated to $T = 0°$ K. was 81·5 gauss/° K. for all three isotopes.

Full details of these experiments will be published later.

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The superconductivity of three samples of separated tin isotopes (identical with those mentioned in the preceding communication) has been investigated with two different methods. In addition to some experiments on the magnetic susceptibility, similar to those carried out by the American authors[1] and in Cambridge, detailed measurements of the dependence of the electrical resistance on temperature and magnetic field have been made. Thin rolled strips of the three isotopes and of natural tin, which had been annealed, were investigated simultaneously by the same method as employed previously[2]. The following results were obtained:

M	116·2	118·7	120·0	123·6
T_c ($H = 0$)	3·764	3·727	3·710	3·653° K.
$T_c M^{1/2}$	4057	4061	4064	4061
Hc (3·5° K.)	39	35	32	23 gauss
Hc (3·0° K.)	108	104	98	90 ,,
Hc (2·5° K.)	169	166	160	151 ,,
Hc (2·0° K.)	220	216	210	202 ,,
Hc (1·5° K.)	259	255	248	241 ,,
Hc (0° K.)	(308)	(305)	(299)	(291) ,,
Hc(0° K.)/T_c	81·8	81·9	80·5	79·9 gauss/deg.
dHc/dT (T_c)	152	163	157	154 ,, ,,
$R_{4.2}/R_{20}$	5×10^{-4}	$2{\cdot}5 \times 10^{-4}$	$1{\cdot}5 \times 10^{-4}$	2×10^{-4} ,,

M is atomic weight; T_c is transition temperature in zero field; H_c is critical field; R_T is resistance at T° K.

As predicted by Fröhlich's theory[3], the product $T_c M^{1/2}$ is a constant. The high purity of the samples is indicated by the low value of the resistivity at 4·2° K. ($R_{4\cdot2}/R_{273} \sim 5 \times 10^{-4}$), as well as by the shape of the H_c—T curves. Below 3° K. the latter are similar parabolas to a high degree of accuracy (~ 1 part in 300), while above this temperature deviations from the parabolic form become significant. In this non-parabolic region there also occur slight changes in the relative position of the H_c—T curves, the positions being, however, rigorously maintained below 3° K. This shift, which may be due to a secondary effect, requires further investigation.

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Nov. 25.

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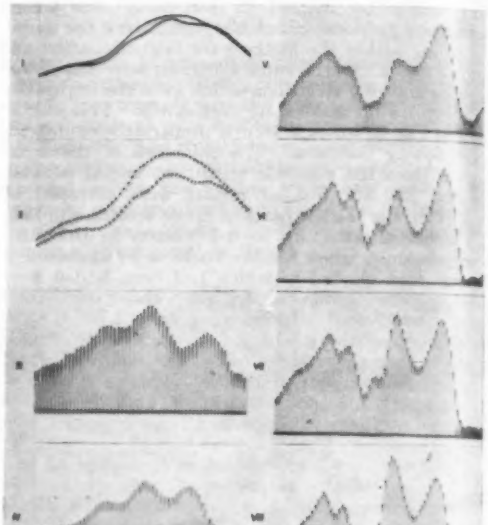
A Double-beam Infra-red Spectrometer with Fast-Scanning Cathode-Ray Tube Display

In the past few years, several workers have shown[1–3] that infra-red spectra can be presented continuously on a cathode ray tube. The presentation of spectra in this way, in scan times as short as several milliseconds, appears to lend itself to the study of rapid chemical reactions and other transient phenomena. In such an investigation of liquid phase reactions, I encountered difficulty in interpreting spectra owing to frequent superposition of bands of the several molecular species involved. To minimize this difficulty, a spectrometer has been designed in which, by a time-sharing double-beam system, spectra giving the percentage difference in absorption between two liquid samples can be displayed as an apparently steady trace on a cathode ray tube.

Two parallel images of a Nernst glower, about 15 mm. apart, are made to fall approximately radially on the teeth of a rotating sector disk. This has 20 teeth, with an equal tooth- and gap-width of 15 mm., and is rotated at 6,000 r.p.m., thus allowing the light beams forming the two images to pass the disk alternately with a switching frequency of 2,000 c./s. The two beams are combined by means of an optical mixing device to give a single image at the entrance slit of the monochromator. Cells containing liquid samples can be inserted in the beams just before they reach the chopping disk. A Littrow spectrometer arrangement with off-axis paraboloid is used, scanning being accomplished by inserting a small moving plane mirror in the beam between the entrance slit and collimating mirror. This plane mirror is mounted on a robust galvanometer coil with strip suspension, the system having a response flat to 100 c./s. A sawtooth wave-form at some frequency between 5 and 25 c./s. is applied to the coil, giving the mirror a constant angular velocity during the scan, and also to the cathode-ray tube X-plates, providing a synchronized time-base for displaying the spectrum. A photo-electric system provides angular calibration of the scanning mirror.

The detector is a lead sulphide cell which feeds a battery-operated head amplifier of high input impedance and band-width 2 c./s.–10 kc./s. The signal when the chopping disk is stopped in one position consists of a series of pulses the tops of which are modulated by the changes of energy as the spectrometer scans the spectrum, separated by gaps produced by inserting a shutter in the radiation stream during the flyback. When the chopping disk is running, there is a ripple at optical switching frequency (2 kc./s.) superimposed on the video pulses and corresponding to the energy difference between beams. For percentage absorption presentation this signal is first used to modulate a 200 kc./s. carrier which is set to zero amplitude between video pulses. This modulated carrier is then adjusted to constant peak level by an amplifier in which the automatic gain-controlling voltage is filtered by a circuit attenuating the optical switching frequency (2 kc./s.) but passing Fourier components of the video signal corresponding to absorption bands (up to 200 c./s.). If the energy of the sample beam never exceeds that of the reference beam, the operation of bringing the peak carrier amplitude to a constant value corresponds to standardizing the reference beam. By rectifying and smoothing the carrier output a 2 kc./s. ripple component can be recovered which corresponds in amplitude to the percentage difference between the sample and reference beams. This is displayed on a blue-screen cathode ray tube from which records are



I. Video traces for water and water + 10 per cent acetone (successive exposures).
II. Video trace showing switching between water and water + 10 per cent acetone.
III. Percentage absorption of acetone at 10 per cent concentration in water (5 per cent peak absorption).
IV. Percentage absorption of pure acetone (50 per cent peak absorption).
V. Percentage absorption difference between (i) 20 per cent N methyl morpholine, 20 per cent dibenzyl phosphite and 60 per cent ethyl alcohol; and (ii) 40 per cent carbon tetrachloride and 60 per cent ethyl alcohol.
VI–VIII. Percentage absorption difference between (i) 20 per cent N methyl morpholine, 20 per cent dibenzyl phosphite, 20 per cent carbon tetrachloride and 40 per cent ethyl alcohol; and (ii) 60 per cent carbon tetrachloride and 40 per cent ethyl alcohol, at 230, 1,020 and 1,930 seconds after start of reaction.
Scans are of 40 m.sec. duration, I–IV covering the range 1·5–2 μ and V–VIII the range 2–2·5 μ, with longer wave-lengths on left

made on fast bromide paper using an electrically operated aircraft camera and an electronic trigger to brighten selected scans.

Performance is at present limited by imperfections of the order of 10 μ in the form of the chopping disk, which shows change-over disturbances varying from tooth to tooth, and by the fact that imperfections in cells and optical mixer prevent the attainment, at the spectrometer entrance slit and at the collimator, of radiation distributions identical for both beams. These set a limiting error in observing differences, over a normal scan, of 2 per cent of the total transmission. From traces I–IV reproduced here, it is seen that a recognizable spectrum (subject to solvent–solute interaction) of acetone in water is obtainable, the peak absorption difference being 5 per cent. Similarly, traces V–VIII (peak absorption difference 10 per cent) show that a chemical reaction in which the total change of transmission at the relevant absorption maximum is less than 5 per cent can be readily followed, but that extensive deviations from Beer's law may be the rule.

This work was carried out during the tenure of an I.C.I. fellowship at the Department of Colloid Science, Cambridge. I am indebted to Messrs. Unicam Instruments (Cambridge), Ltd., who built the spectrometer, and to the Institute of Petroleum for their support of the work.

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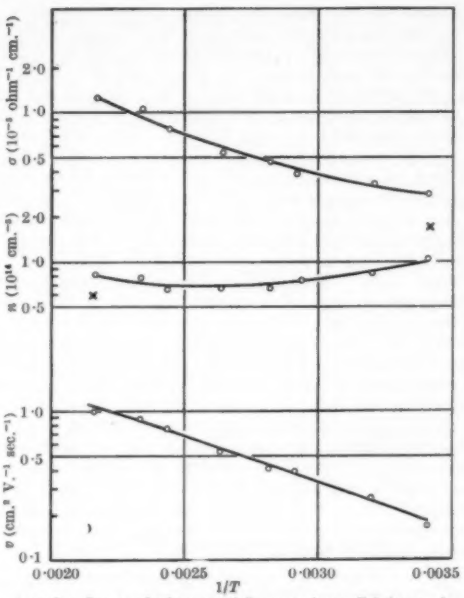
Hall Effect in a Selenium Single Crystal

In a recent communication[1], measurements of conductivity and thermo-electric power of selenium single crystals were reported. These have now been supplemented by a determination of the Hall effect on one such crystal. An A.C. method of measurement was used in which direct current was passed through the specimen held in a magnetic field alternating at 80 c./s. This was found necessary in order to reduce the noise-level below that of the signal.

Both the Hall effect and the thermo-electric power (θ) yield values for the concentration (n) of free electrons (or positive holes), the formula giving θ in terms of n and T being[2]

$$\theta = \frac{k}{e}\left(2 + \log \frac{2(2\pi mkT)^{3/2}}{h^3} - \log n\right).$$

A preliminary interpretation of the previous results of thermo-electric measurements along these lines yielded the rather surprising result that n is constant or even falls with increasing temperature, while the conductivity rises in the usual exponential manner. The Hall effect measurements, giving an independent value of n, have now confirmed this result, at least qualitatively. Thus, it appears that in selenium crystals the conductivity varies by virtue of the mobility rising exponentially with increasing temperature, while the value of n remains substantially constant. The accompanying diagram shows the conductivity σ, carrier concentration n (from Hall effect) and the derived mobility v plotted on logarithmic scales against $1/T$. The values of n obtained from the thermo-electric power are represented by the two crosses. (The experimental error in the n and v values by Hall effect and by thermo-electric power is about the same, $\pm$ 25 per cent.)



σ, n and v for a selenium crystal, current parallel to c-axis; ×—×—, values from thermo-electric power

The very low mobility and its variation with temperature support the hypothesis of internal barriers put forward by Müller[3] to account for the deviations from Ohm's law observed with selenium crystals.

Henkels[4] has recently published thermo-electric measurements on selenium and values of n and v derived from them. These are in agreement, well within an order of magnitude, with the results obtained here.

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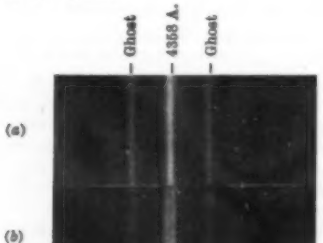
Brillouin Components in Light Scattered by Quartz

It was first observed by Gross[1] that, when the 4358-A. line of mercury scattered by quartz is examined with a 30-step echelon grating, the line is found to be split up into a doublet, each component being shifted from the centre of the line by 0·18 A. He reported later[2] that the line is split up into six components. Krishnan and Chandrasekharan[3] have recently studied the structure of the 2536·5-A. line of mercury scattered by quartz and filtered through mercury vapour, using a 3-metre quartz spectrograph having a dispersion of 13 cm.$^{-1}$ per mm. in this region. They have observed a weak doublet, each

component of which is shifted from the centre of the line by different amounts for different settings of the crystal. With the direction of incidence along the Y-axis and scattering along the Z-axis of the crystal the shift is 1·90 cm.$^{-1}$. This shift is too large to be accounted for by the difference in the refractive indices for 4358 A. and 2536 A. The intensity of the displaced components is also only a small fraction of that of the undisplaced line. Hence these results are not in agreement with those observed by Gross.

In order to find out the cause of this discrepancy, the investigation has been repeated with a technique in which the mercury vapour filter has been dispensed with. The 4358-A. line of mercury incident along the Y-axis of a quartz crystal of dimensions 3 cm. × 2·5 cm. × 5 cm. and scattered along the Z-axis has been photographed in the third-order spectrum produced by a 12-ft. concave grating having a dispersion of 1·5 A. per mm. and a resolving power of about 40,000. The spectrogram is reproduced herewith. The 4358-A. line is accompanied by strong ghost lines on each side; but it can be clearly seen that each of these lines consists of a doublet without any central component between the two outer components. Thus the incident line is split up into only two Brillouin components during the process of scattering by quartz.



(a) Incident; (b) scattered. *B*, Brillouin component

The shift of each component from the centre of the line is 0·179 A. or 0·95 cm.$^{-1}$. The refractive indices of quartz for the two wave-lengths 4358 A. and 2536 A. are 1·55 and 1·60 respectively. Hence the expected shift in the region of 2536 A. is 1·68 cm.$^{-1}$. Krishnan and Chandrasekharan have observed only a weak doublet, each of the components being shifted from the centre of the 2536·5-A. line by 1·90 cm.$^{-1}$. Evidently, the main Brillouin components in their arrangement have been absorbed by the mercury vapour filter, and the larger frequency-shift of the weak doublet observed by them may have been produced by some scattering process in the absorbing mercury vapour observed previously by one of us[4]. Thus the method used by them is not suitable for studying the Brillouin components.

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Use of Coaxial-Cylinder Viscometers and Capillary-Tube Viscometers for Suspensions

When a capillary-tube viscometer is used for determining the apparent viscosity of a suspension of discrete, solid particles in a liquid, it is found that the measured viscosity varies with the bore of the capillary, increasing with increasing diameter. This effect, termed the sigma phenomenon, has been investigated by several workers, but in particular by Vand[1] and de Bruijn[2], both of whom examined the rheological properties of suspensions of spherical glass particles in liquids inert to glass.

Vand, in a mathematical treatment of the problem, suggested that at the wall of the tube through which a suspension is flowing, there would be a layer of the liquid phase having a thickness dependent only upon the particle diameter of the solid phase. Under certain conditions, therefore, the thickness of the layer would constitute a substantial proportion of the radius of the capillary, and the flow of this liquid film would give rise to the observed effect.

De Bruijn attributed the sigma phenomenon to the interaction of particles in a suspension subjected to shear. Dix and Scott Blair[3] had proposed a theory in which they assumed that the streamlining layers were not infinitely thin, and that flow took place by the telescoping of concentric fluid layers of equal thickness. Extending this theory, de Bruijn obtained an expression relating the sigma phenomenon to the concentration of the solid phase.

Both theories lead to the conclusion that the effect should also be observed in a coaxial-cylinder type viscometer, resulting in an increase of apparent viscosity with increasing annular-gap widths. In the course of extensive investigations of the factors affecting the viscosity of suspensions (the results of which will be published in full elsewhere), we have made measurements on stable suspensions of closely sized, spherical, methyl methacrylate polymer particles, having mean diameters varying from 38 to 388 microns, in an aqueous solution of lead nitrate and glycerol. Apparent viscosities were determined in a Couette-type viscometer, using annular gaps of 2, 3 and 4 mm., up to volume concentrations of 20 per cent.

Within the range investigated (ratios of annular gap to particle diameter from 5 : 1 to 110 : 1), no sigma phenomenon was detected, and in all cases the viscosity was independent of the rate of shear. The latter characteristic has already been noted when measuring the viscosity of similar suspensions using a rising-sphere viscometer[4], but the fact that the apparent viscosity is independent of gap width in a Couette-type instrument appears to be new. The reason for, and the significance of, this observation are not immediately clear, but it leads to the possible conclusion that coaxial cylinder viscometers are to be preferred to capillary-tube viscometers for measurement of the viscosity of stable suspensions.

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The New Einstein Theory and the Equations of Motion

THE new Einstein[1] theory is mathematically attractive; but its role in science can only be established through the conclusions that can be drawn from it. Einstein himself hopes that his new theory will turn out to be a real field theory, that is, he believes that his equations possess solutions free from singularities and representing particles. To show that such solutions exist (or that they do not) is a difficult task. But we can ask a simpler question: Does the new Einstein theory give equations of motion which are consistent with experience? That is, do we obtain, in the first approximation, the Lorentz equations of motion?

In a series of papers[2], the problem of motion, as determined by the field equations alone, was investigated according to general relativity theory. The same method in principle, though with some appropriate changes, can be applied to Einstein's new theory. Unfortunately, the equations of motion remain Newtonian and are uninfluenced by the electromagnetic field.

Yet it is possible that this negative result is no fault of Einstein's theory, but of the conventional interpretation by which it was derived. Indeed, the derivation is based on the assumption that far from the 'centre' of a particle the symmetric part of the metric tensor characterizes the gravitational field, and the antisymmetric part the electromagnetic field.

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Reduction of some Cyclic Amides by Lithium Aluminium Hydride

ON reduction by lithium aluminium hydride, amides usually give amines[1]: it has now been found that N-methyl phenanthridones behave rather differently, yielding quaternary (phenanthridinium) compounds. Phenanthridones are reduced to phenanthridines. Thus, N-methyl phenanthridone and N-3-dimethyl phenanthridone (m.p. 139°; found: C, 80·6; H, 5·8; N, 6·15 per cent; calc. for $C_{15}H_{13}ON$: C, 80·7; H, 5·8; N, 6·3 per cent) reduced in ethereal solution on the 300-mgm. scale gave respectively 60 and 55 per cent yields of the quaternary iodides (3-methyl phenanthridine methiodide, m.p. 278°; found: C, 53·8; H, 4·1; N, 4·5; I, 37·4 per cent; calc. for $C_{15}H_{14}NI$: C, 53·75; H, 4·2; N, 4·18; I, 37·9 per cent). The analogous N-methyl quinolone likewise gave N-methyl quinolinium chloride (identified as its platinichloride), but the reaction was less easy, two hours refluxing in dibutyl ether giving a 20 per cent yield. Among the reduction products of N-methyl pyridone, only a trace of quaternary compound (isolated as picrate) was found, together with methylamine (7 per cent isolated as the platinichloride).

Phenanthridone and 1-methyl phenanthridone (m.p. 240°; found: C, 80·0; H, 5·3 per cent; calc. for $C_{14}H_{11}ON$: C, 80·4; H, 5·3 per cent) reduced on the 100-mgm. scale gave respectively 70 and more than 50 per cent yields of the corresponding phenanthridines: no precautions were taken to prevent air-oxidation of any dihydro derivative which was formed[2]. 2-Hydroxy quinoline reduced (6 hr.) in boiling dibutyl ether gave quinoline (26 per cent as the picrate) and, isolated chromatographically, tetrahydroquinoline (5 per cent as the benzoyl derivative); 2-hydroxy pyridine similarly gave pyridine (8 per cent as the picrate) and piperidine (1·5 per cent as the *p*-toluenesulphonyl derivative). Pyridine refluxed in dibutyl ether with lithium aluminium hydride for 3 hr. gave a 10 per cent yield of piperidine (isolated as the *p*-toluenesulphonyl derivative), no unchanged pyridine being recovered.

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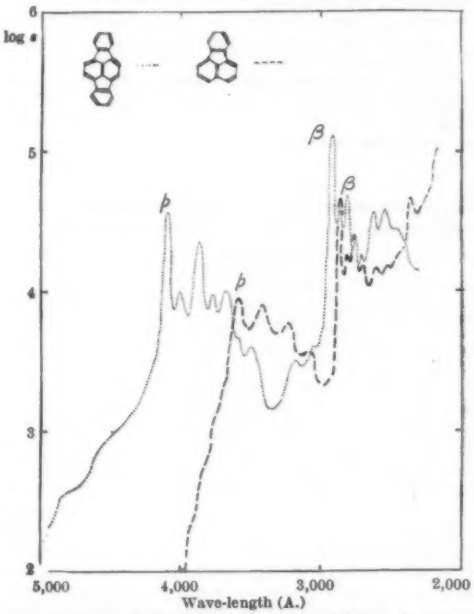
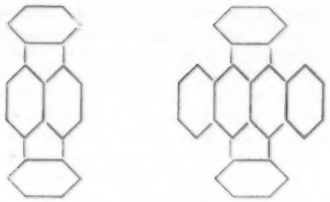
bis-peri-Phenylenenaphthalene

bis-peri-Phenylenenaphthalene (I) has been synthesized, and the preparation will be described (by H. W. D. S. and S. H. T.) in a forthcoming communication.

We describe herein the ultra-violet absorption spectrum of this hydrocarbon. In the accompanying graph its spectrum is superimposed on that of fluoranthene. The *p*-bands[1] are clearly separated from β-bands[1], but the general similarity of the curves is so great that one may say that: (i) the



Absorption spectra of *bis-peri*-phenylenenaphthalene (....) and of fluoranthene (– – – –) in ethanol. Band maxima (in A.), *bis-peri*-phenylenenaphthalene: *p*-bands 4100, 4020, 3870, 3795, 3670, 3490. β-bands 2925, 2865, 2810, 2760, 2705. β'-bands 2625, 2530. Fluoranthene: *p*-bands 3585, 3420, 3230, 3090. β-bands 2870, 2820, 2760, 2715, 2615, 2525, 2450. β'-bands 2360



I II

pronounced resemblance in fine structure of the β-bands indicates a close electronic relationship between the two hydrocarbons; (ii) the very small shift in wave-length of the β-band group of *bis-peri*-phenylenenaphthalene in relation to that of fluoranthene is probably due to almost complete lack of interaction of the π-electrons of one phenylene ring-system with those of the other; (iii) on the other hand, the *p*-bands of *bis-peri*-phenylenenaphthalene are shifted considerably towards the red end of the spectrum.

It is of interest to compare these spectra with that of 5 : 6 : 11 : 12-diphenylenetetracene (II)[2]. The first *p*-band in the spectrum of (II) occurs at 6100 A., whereas that of *bis-peri*-phenylenenaphthalene (I) is at 4100 A.; this shift corresponds to an increase of about two anellation units[3], thus harmonizing with the relative data for naphthalene and tetracene. It follows that *p*-absorption in *bis-peri*-phenylenenaphthalene and in fluoranthene is located in the naphthalene and in (II) in the tetracene ring system present in these hydrocarbons.

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Permanganate as a Spraying Reagent for Amino-acids on Paper Chromatograms

Potassium permanganate (1 per cent solution, containing 2 per cent sodium carbonate) has been recommended[1] as a spraying reagent for detecting carbohydrates on paper chromatograms. When testing this reagent on a chromatogram irrigated with butanol/acetic acid and carrying amino-acids as well as carbohydrates, an anomalous spot was observed, which was traced to methionine. It has now been found that if a paper chromatogram be lightly sprayed with the permanganate reagent, methionine, tryptophane, tyrosine and (more weakly) proline and histidine immediately appear as yellow spots on a red background. As the paper dries the colour difference tends to disappear, leaving the spots and background different shades of brown. The spots should therefore be marked at once. Cysteine also gives a spot, but does not normally occur on a paper chromatogram[2]. Threonine, hydroxyproline, lysine and glycine show up on standing a few minutes. Other amino-acids normally occurring in protein hydrolysates do not show at the concentrations encountered in paper chromatography.

The reaction is especially sensitive to methionine, and may be of value as a confirmatory test for this amino-acid. The reagent is not applicable when phenol has been used as irrigating solvent.

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Electrolytic Detection of Alkali Salts on Filter Paper

Since the work of Lederer[1] and Arden *et al.*[2], the separation of inorganic cations by paper chromatography has been developed rapidly. The alkali salts, however, do not appear to have been studied, because of the difficulties of detection of alkali cations on the filter paper. We have recently discovered a simple electrolytic method of detecting the alkali and alkaline earth cations, and have studied the paper chromatography of the alkali salts.

The principle of this method is the cathodic production of alkali hydroxides by the electrolysis of aqueous solutions of alkali salts. The procedure is as follows. The paper strip is dried to drive off the developing solvent, and the saturated alcohol/water solution (1 : 1) of phenolphthalein is sprayed on it. Then the paper is electrolysed by D.C. (6 V., about 5 sec.), being held between flat graphite electrodes (cathode upper). A red spot indicates the existence of alkali salts. The limits of detection with this method are tabulated in the accompanying table.

Limits of Detection of Potassium Chloride

	Developing solvent	Distance of migration	Limits of detection
Before development			$1\gamma/10^{-6}$ ml.
After development	Butanol + ammonia	1 cm.	$5\gamma/10^{-6}$ ml.
	Butanol + acetic acid	6 cm.	$10\gamma/10^{-6}$ ml.

The values in the table show that this method can be applied satisfactorily to the chromatography of alkali salts; but the small amount of acid that cannot be removed by drying the paper reduces the sensitivity.

Some results so far obtained are as follows. (1) Filter paper for qualitative analysis (Tōyō Roshi, No. 2) is unsuitable for the chromatography of alkali salts, because it contains considerable amounts of these salts. For this reason we use quantitative analysis filter paper (Tōyō Roshi, No. 3) in our experiments. (2) Although the lithium ion is easily separated from other alkali ions, the separations of other ions are very difficult with ordinary solvents. (3) Potassium chloride is easily separated from iodide with butanol/acetic acid solvent. Chromatographic analysis of the anions of alkali salts will be possible by selecting suitable solvents.

We are now studying the separations of the alkali cations and various anions with this method.

We wish to acknowledge the suggestion of Prof. T. Titani.

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Use of 'Amberlite *IRC*-50' for the Partial Purification of a Bacterial Pectinase

IN the course of an investigation of the pectolytic enzymes of certain plant pathogens, it was found possible to effect a partial purification of bacterial pectinase with a cation exchange resin, 'Amberlite *IRC*-50'.

A separation of pectinesterase and polygalacturonase with 'Amberlite *IR*-100' has been reported by McColloch and Kertesz[1], though the validity of their method has been questioned by Lineweaver, Jang and Jansen[2]. Their objection to the use of Amberlite *IR*-100, namely, the development within the column of rather low *p*H values (*p*H 1·0–2·0), was eliminated in the present investigation by using 'Amberlite *IRC*-50', which is a weak-acid cation exchanger readily buffered at any desired *p*H value over a wide range.

The pathogen, *Bacterium aroideæ*, was grown in a liquid medium of the following composition: glucose 1, peptone 0·5, potassium dihydrogen phosphate 0·08, magnesium sulphate 0·03, calcium carbonate 1·0, water to 100 per cent. After five days, the culture fluid was centrifuged at 4,000 r.p.m. for 20 min. to remove most of the bacteria, excess carbonate, etc., and the *p*H adjusted to 7·6.

A suspension of the sodium-salt form of the resin was treated with *N*/10 hydrochloric acid to bring the *p*H to 7·6–7·8, and then allowed to settle as a sediment to form a column 20 cm. × 1 cm. The system was such that no further buffering was required.

In a typical test, 50 ml. of centrifuged culture filtrate was passed through the column at an effluent rate of about 1·25 ml./min. After thorough washing of the column with distilled water, the adsorbed enzyme was eluted with 15 ml. of *N*/10 hydrochloric acid, the effluent rate being 1·0 ml./min., and the *p*H of the effluent about 6·2–6·4. It should be pointed out that though *N*/10 acid is used as an elutant, it is rapidly neutralized by exchange with sodium ions from the resin, and in view of the slow rate of flow, the *p*H of the major part of the column probably does not fall below 6·0. Sodium chloride was removed from the enzyme solution by dialysis through 'Cellophane'. 1 ml. of the dialysed solution caused complete hydrolysis of 5 ml. of 1 per cent sodium pectinate solution in 15 min. This was of the same order as a dialysed preparation of the crude culture fluid, so that although considerable quantities of impurities are removed in the process there is an appreciable loss of pectolytic enzyme.

Further details of the investigation are to be published elsewhere.

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Reduction by Molecular Hydrogen of Acetoacetate to Butyrate by Butyric Acid Bacteria

Stadtman and Barker[1,2], working with extracts of *Cl. kluyveri*, and Cohen and Cohen-Bazire[3–5], using suspensions of butyric acid bacteria, found that acetoacetate is split into two C_2-carbon residues. These workers found acetate from acetoacetate, whereas Stadtman and Barker observed a phosphoroclastic splitting of acetoacetate to acetate and acetyl phosphate. It should be noted that the suspensions utilized by Cohen and Cohen-Bazire possess strong acetyl phosphatase activity. Nisman[6], utilizing extracts of the same bacteria obtained by ultrasonic vibration, finds that pyruvate yields considerable amounts of acetyl phosphate.

The reverse reaction, that is, the synthesis of acetoacetate from acetate and acetyl phosphate, has been postulated by Lipmann[7] as a step in the synthesis of butyrate from pyruvate. Stadtman and Barker[2], in an attempt to achieve this reaction, find only small but none the less significant amounts of a β-keto acid which they think to be acetoacetic acid. β-Keto acid accumulates in greater quantity in presence of 0·002 *M* hydrogen cyanide. Incubation of extracts of *Cl. kluyveri* with acetate, acetyl phosphate and hydrogen leads to a synthesis of butyrate[8], whereas acetoacetate incubated with hydrogen under the same conditions gives rise, almost mole per mole, to β-hydroxybutyrate, which is not further metabolized, and to traces of butyrate. In view of these results, Stadtman and Barker[2] come to the conclusion that acetoacetate is not a precursor of butyrate. This assumption is supported by further experiments conducted by the same workers with carbon-14 labelled compounds.

On the other hand, we[4,5] have shown that suspensions of butyric acid bacteria may utilize lactate or pyruvate as hydrogen donors for the transformation of acetoacetate to butyrate. With 'deficient' suspensions[9], pyruvate or acetoacetate alone give rise only to acetate; simultaneous incubation with both pyruvate and acetoacetate leads to the formation of butyrate. In view of Stadtman and Barker's experiments, it was interesting to study the reduction of acetoacetate by molecular hydrogen. Since we have found β-hydroxybutyrate to be fermented *in vacuo* to acetate and butyrate[5,10], we have also studied its behaviour in a hydrogen atmosphere. Our results are summarized in Table 1.

It is seen from these results that, contrary to what occurs *in vacuo*[5,10], β-hydroxybutyrate is not metabolized in an atmosphere of hydrogen. This is consistent with Stadtman and Barker's observations. In

Table 1. Suspensions are prepared as previously described (ref. 9). Each Warburg vessel contained in the main part phosphate buffer *M*/45, substrate and water to adequate volume; 0·2 ml. 20 per cent potassium hydroxide in the central well; 0·5 ml. bacterial suspension in the side bulb. Total volume: 3·2 ml. Suspension and substrate are mixed after 15 min. equilibration. Temperature: 37° C.; *p*H 7; gas phase, hydrogen. The data have been corrected for hydrogen absorption of the suspension alone. The results are expressed in micromoles

Strain	Acetoacetate Initial	Acetoacetate Final	Δ Acetoacetate	Hydrogen	β-Hydroxybutyrate Initial	β-Hydroxybutyrate Final
Cl. acetobutylicum PC48	43	0	43	32	—	11·3
,,	—	—	—	0	13·7	13·5
Cl. saccharobutyricum GR4	—	—	—	0	13·7	13·4

Table 2. Strain *PC48*. Same conditions as in Table 1. Sodium arsenite, *M*/300. When volatile acid determinations were done, the experiments were run in a series of six to eight vessels. Since the consumption of hydrogen was identical in the different vessels, the various determinations were made on a pooled sample. The data have been corrected for hydrogen absorption, butyrate and acetate formation of the suspension alone. The results are expressed in micromoles.

	Number of vessels	Acetoacetate		Hydrogen	β-Hydroxybutyrate formed	Butyrate formed	Acetate formed	Hydrogen / Acetoacetate	Butyrate / Acetoacetate	Hydrogen / Butyrate
		Initial	Disappeared							
I										
Without As	8	344	344	208	104	50	300	0·6	0·14	4
With As	8	344	184	264	8	144	10	1·4	0·78	1·8
II										
Without As	1	43	43	28	10	—	—	0·65	—	—
With As	6	258	246	432	6	200	40	1·75	0·81	2·1

the case of acetoacetate, 25–30 per cent is reduced to β-hydroxybutyrate; this also agrees with the results of these authors. Most of the remainder is split to acetate, while a small amount only is reduced to butyrate (see also Table 2). The possibility cannot be excluded, at least with the 'normal' suspensions[9], that this small amount of butyrate is not derived from a previous splitting of the acetoacetate followed by a recondensation of two C_2 residues to another C_4 intermediary compound. This is less probable with the 'deficient' suspensions, which are unable to produce butyrate unless a C_4 compound is available.

Sodium arsenite (*M*/1,000) inhibits the splitting of acetoacetate to acetate by suspensions of the butyric acid bacteria[8]. On the other hand, while the ratio of butyrate to acetate produced from β-hydroxybutyrate *in vacuo* remains unchanged in its presence, this inhibitor reduces considerably the total volatile acids produced from this substrate. By raising the concentration of arsenite to *M*/300, we have found it possible to inhibit almost completely the fermentation of β-hydroxybutyrate. The latter is fermented *in vacuo* by the intermediary of acetoacetate, the suspensions possessing an active β-hydroxybutyric dehydrogenase[11].

In the transformation of acetoacetate to butyrate, these two actions of arsenite allow us to discount the possibility of a preliminary splitting to acetate. Actually, in the presence of *M*/300 arsenite and acetoacetate: (*a*) the ratio of hydrogen consumed to acetoacetate metabolized is more than doubled; (*b*) traces only of β-hydroxybutyrate are produced; (*c*) practically no splitting of acetoacetate occurs and butyrate is the main, if not the only, product of the reaction.

The data in Table 2 show these results, which are visualized by the following scheme:

$$2\,CH_3COOH \leftarrow CH_3COCH_2COOH \rightarrow X(?) \rightarrow CH_3CH_2CH_2COOH$$
$$\downarrow \uparrow$$
$$CH_3CHOHCH_2COOH$$

In the absence of arsenite, three reactions compete for the utilization of acetoacetate: splitting to acetate, reduction to β-hydroxybutyrate, and reduction to butyrate.

The above results demonstrate that in the presence of arsenite the two first reactions are inhibited, two moles of hydrogen being utilized per mole of butyrate produced. The overall reaction in the presence of arsenite is:

$$CH_3COCH_2COOH + 4\,H \rightarrow CH_3CH_2CH_2COOH + H_2O.$$

This reduction may involve an intermediate in the same state of oxidation as β-hydroxybutyrate, this compound itself being definitely excluded as an intermediate in butyric acid synthesis by the organisms utilized in this study.

In vacuo, the reaction $CH_3COCH_2COOH \rightarrow CH_3CHOHCH_2COOH$ proceeds towards the left, while in an atmosphere of hydrogen the equilibrium is shifted to the right and β-hydroxybutyrate is not fermented.

These results, while not allowing us to state with any assurance whether acetoacetate is actually an intermediate in butyric acid synthesis, nevertheless show that it can be reduced directly to butyrate and make it worth while to re-investigate the problem more closely.

A detailed paper will be published elsewhere.

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Energetics of Uterine Muscle Contraction

LUNDSGAARD[1] has shown that the energy liberated by striated muscle, poisoned by monoiodoacetic acid under anaerobic conditions, is proportional to the breakdown of creatine phosphate. He has also shown that under these conditions adenosinetriphosphate[2] also disappeared on stimulation. In view of these facts, and Lohmann's[3] findings on the phosphate transfer between creatine phosphate and adenine compounds, it can be assumed that adenosinetriphosphate and creatine phosphate together form the store of immediately available energy in muscle. According to Lundsgaard, a muscle poisoned by monoiodoacetic acid can perform about a hundred contractions in nitrogen. The energy of these contractions is derived solely from the stored high-energy phosphates, which, under normal conditions, are regenerated by carbohydrate metabolism.

It appears of interest to study uterine muscle with the view of establishing the energy requirements of a contraction. Corner and Csapó[4], studying the contraction of uterine strips (sow) after electrical stimulation, observed that inhibition of glycolysis by

PHOSPHORUS FRACTIONS IN UTERINE AND SKELETAL RABBIT MUSCLE
(Means with standard errors)

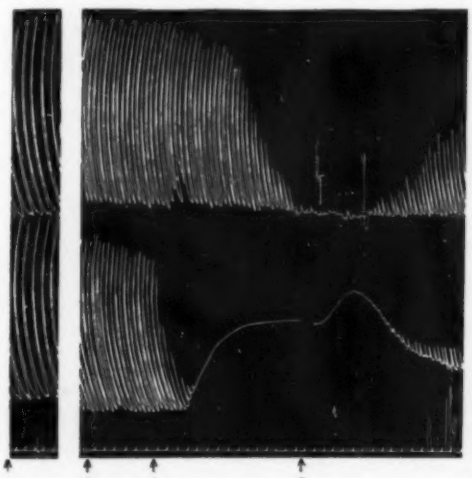
	Inorg. P (μM/gm. wet weight)	CrP (μM/gm. wet weight)	ATP (μM/gm. wet weight)	CrP + ATP (M/gm.)
Uterus*	5·17±0·36	0·74±0·09	1·90±0·09	2·64
Skeletal muscle	10·82±0·79	10·50±1·42	7·00±0·43	17·50
Ratio S/U				6·63

* Five animals in œstrus, three in fifth day of pregnancy. Since there was no significant difference between the two groups, the means were calculated from the pooled data.

Lohmann (ref. 8) has reported one determination of the acid labile phosphorus content of rabbit uterus corresponding to 1·34 μM of adenosinetriphosphate per gm.; Eggleton and Eggleton (ref. 9) have also published the result of one experiment, the values being 1·40 μM of adenosinetriphosphate and 0·45 μM of creatine phosphate per gm.

monoiodoacetic acid together with exclusion of oxygen reduced the number of contractions which could occur before complete exhaustion. A chemical study of the high-energy phosphates of uterine muscle together with a quantitative study of the monoiodoacetic acid effect seemed, therefore, desirable. The ratio of the amount of high-energy phosphates to the number of contractions with monoiodoacetic acid might indicate the energy requirement of one contraction cycle, and this quantity could be compared with available data on striated muscle.

Rabbits weighing about 8 lb. were anæsthetized with 'Nembutal'; the uteri were quickly removed and frozen in a mixture of dry carbon dioxide and ether. Frozen samples of about 0·5 gm. were pulverized, weighed and then homogenized with sea-sand in 8 ml. of ice-cold 5 per cent trichloroacetic acid. The extract was centrifuged at 0° in a refrigerated centrifuge and the supernatant was used for analysis. Analyses were made for inorganic phosphate, creatine phosphate, and acid labile phosphorus (9 min. boiling in 1 N hydrochloric acid). Phosphate was determined by the method of Fiske and SubbaRow[5]. Creatine phosphate was obtained as the difference between the 20-min. reading and the extrapolated value at zero time. The latter was the value of orthophosphate. Duplicate determinations of inorganic phosphate by precipitation of the calcium salt from the neutralized trichloracetic acid extract were in satisfactory agreement. The results are given in the accompanying table. For comparison we have included the results of similar determinations on rabbit psoas muscle. We have expressed the labile phosphate as adenosinetriphosphate (1 mole of the latter is equivalent to 2 moles labile phosphate). These results indicate that the amount of readily available energy per gram is considerably smaller in uterine than in striated muscle.



In vitro effect of anoxia (upper graph) and anoxia + monoiodoacetic acid poisoning (lower graph) on excised rabbit uterine strips. *A*, spontaneous contractions; *B*, electrical stimulation every 30 sec.; *C*, oxygen off, nitrogen on, M/10,000 monoiodoacetic acid is added to the lower strips; *D*, oxygen on, nitrogen off; bath change for lower strip. Time signal, 1 min.

The accompanying record shows the result of a typical stimulation experiment in nitrogen with and without monoiodoacetic acid. Monoiodoacetic acid considerably reduces the number of contractions the uterus can perform. (Similar results were obtained in three experiments on rabbit uterus strips and in four experiments on sow uterus strips.) In view of our finding a smaller amount of high-energy phosphates in uterine muscle, it is interesting to note that in monoiodoacetic acid poisoning there are only about ten contractions in contrast to 70–100 in the case of striated muscle. We assume that after exhaustion of the monoiodoacetic acid-treated uterine muscle similar changes occur as in striated muscle, though this point requires further investigation. In comparing the energy available in high-energy phosphate bonds with the number of contractions, one has to decide whether to count one or two phosphate bonds for an adenosinetriphosphate molecule.

Inspection of Lundsgaard's[2] data shows that in exhausted striated muscles all the creatine phosphate disappears plus about half of what he called pyrophosphate. On this basis it seems justifiable to take creatine phosphate plus adenosinetriphosphate in moles as a measure of the available energy. The ratio of energy to contractions seems to be of the same order in monoiodoacetic acid-poisoned striated and uterine muscle. In terms of high-energy phosphate bonds, it corresponds to about 0·25 μM/contraction/gm. Hill[6] has measured the initial heat of a single striated muscle contraction directly and finds it to be 3 mcal., and from this calculated[7] a value of 0·25 μM phosphorus/contraction/gm., which is identical with our result.

Thus we have shown that uterine muscle contains about one-seventh of the high-energy phosphates in striated muscle, but the energy requirements for a single contraction appear to be of the same order of magnitude in both muscles. A more detailed study is in progress with particular emphasis on the enzymatic determinations of the various nucleotides that may play a part in the energy supply of uterine muscle.

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Epidermal Transplantation during Chemical Carcinogenesis

In the study of the mechanism of epidermal carcinogenesis, it is perhaps not surprising that attention has been mainly directed to the epithelium of the epidermis itself. Nevertheless, changes occur in the dermis and subcutis which can be distinguished from the effects of non-specific irritants, and it has been suggested that these changes are of importance in the carcinogenic reaction[1]. As it is now technically possible to make pure epidermal grafts[2], the opportunity has been taken to test this hypothesis by transferring the epidermis of a carcinogen-treated site to an untreated body-site, and *vice versa*.

Mice were painted with methylcholanthrene (0·3 per cent in acetone) once a week for twelve weeks on the skin of the right scapular region (referred to as the 'treated area'). They were then left untreated for two weeks, the few animals with tumours discarded, and the remainder subjected to one of the following operations:

(*a*) Epidermis removed from treated area, to which tail skin epidermis was transplanted.

(*b*) Epidermal grafts from treated area transplanted to a bed prepared by removing the epidermis from the left dorsal thorax (referred to as the 'grafted area').

(*c*) Thiersch grafts (that is, epidermis and superficial dermis) from treated area transplanted to grafted area (single bed).

(*d*) Thiersch grafts of treated area transplanted to four separate beds in grafted area.

Results of experiments:

(*a*) Of 21 survivors when the first tumour appeared in this group, 12 have developed tumours on the treated area in an average time of 78 ± 17 days after operation.

(*b*) 28 survivors at first tumour: 13 tumours on the treated area in 93 ± 16 days; no tumours on the grafted area.

(*c*) 7 survivors; 4 tumours in 92 ± 45 days (3 of these definitely on the treated area, the other doubtful in position). In addition, one of the mice had a nodule on the grafted area, which had the histological structure of an implantation epidermoid cyst.

(*d*) 8 survivors; 5 tumours in 67 ± 37 days, all on the treated area. No tumours on the grafted area.

The validity of these results obviously depends on the grafts having 'taken' adequately. They appeared to have done so, but it is not yet possible to be as certain on this point in the mouse as it would be in larger rodents. The part played by the hair follicles has to be taken into consideration; the deep parts are necessarily left *in situ* during grafting, while the superficial parts are presumably transferred with the graft. Histological examination does not suggest that a considerable proportion of the tumours originated in hair follicles, and the negative results on the grafted area in experiment (*b*) may be significant.

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Oct. 11.

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Estimation of Collagen in Hard Tissues

In analysing the protein constituents of connective tissues, it is usually assumed that collagen is represented by a fraction of the total nitrogen which is precipitable by tannic acid after autoclaving the washed sample. The existing procedure for the determination of this protein in bone[1] was applied to dentine[2], but later shown to be unsatisfactory. Preparation of the powdered sample by grinding results in the conversion of at least one-tenth of the collagen to gelatin. Drastic autoclaving conditions account for the failure to precipitate a similar fraction of the protein thus made soluble, while somewhat more of the gelatin remains adsorbed on the autoclaved dentine powder even after washing with boiling water. These facts became apparent when a purified hide collagen sample[3] was mixed with the correct proportion of the residue prepared by extracting dentine with boiling alkaline ethylene glycol and analysed under the same conditions.

Percentages of Total Nitrogen found in Fractions obtained when Samples are Washed and the Gelatin (Released by Autoclaving) Precipitated with Tannic Acid

Sample	Soluble in water	Soluble on autoclaving: Precipitate	Soluble on autoclaving: Filtrate	Adsorbed on residue
Dentine collagen	0	91	8	0
Hide collagen	0	91	9	0
Dentine collagen*	0	81	7	12
Hide collagen*	0	82	7	12
Crushed dentine*	5	65	7	24
Crushed dentine	5	75	8	12
Ground dentine	15	66	6	13

* Added to an equivalent quantity of deproteinized dentine.

The fractions thus obtained were then examined after hydrolysis by comparing their amino-acid 'spectra'. These were obtained by using a method[4] which has been applied here to the characterization of proteins. Ninhydrin-developed paper chromatogram strips were passed through a photo-electric colorimeter and the optical densities then plotted against the distances travelled by the amino-acids. Water-soluble protein from crushed dentine was thus shown to be gelatin. Included with the gelatin fraction adsorbed on the residue left after autoclaving was an insoluble protein, amounting to 1 per cent of the total collagen and giving a 'spectrum' which was not typical of collagen, elastin or reticulin; the residue from hide collagen has similarly been differentiated[4].

Further evidence as to the amount of collagen in hard tissues is provided by a method which may have useful applications as it avoids both drying and weighing the samples to be analysed. Convenient volumes of dilute phosphoric acid solutions containing dentine or the isolated collagen were digested with (*a*) sulphuric acid, using a peroxide catalyst, and (*b*) a dichromate–sulphuric acid reagent[5]. From (*a*) the total nitrogen was estimated colorimetrically, and from (*b*) the amount of oxidant consumed was calculated after iodometric titration. The ratio of *a* to *b* was expressed as 'mgm. nitrogen/ml. *N* thiosulphate', and measured the relation between protein and total organic matter. Ratios obtained by analyses on deciduous dentine, on incisor, canine, premolar and molar permanent dentine, varied by less than 1 per cent from their mean, which was definitely less than the single ratio equally applicable to the isolated collagens from dentine, bone and ox hide.

It is thus clear that only citric acid (0·9 per cent)[7], mucopolysaccharide (0·2 per cent) and fat (0·2 per cent), which were also estimated, can otherwise be present in significant quantities in dentine.

In connexion with this revision, attention may be directed to the widely ignored complaint[8] that incineration procedures as used are misleading if the amount of organic matrix in hard tissues is to be studied. The same objection—that combined water is also removed from the 'moisture-free' samples—applies when the organic matter is removed by extraction with alkaline ethylene glycol. However, Tomes considered that the combined water was released from the inorganic salts by incineration, whereas the present finding that water retained after drying at 100° is not retained by the residue dried after autoclaving at 120° favours the opinion that it is bound by the collagen. All the collagen samples from bone and dentine showed 18·3–18·4 per cent total nitrogen, as did hide collagen, after drying for 2 hr. at 100°. Prolonged drying is necessary to obtain the 18·6 per cent reported for hide collagen[3] prepared in the same way as the sample used for this comparison and kindly supplied by Dr. Joane H. Bowes of the British Leather Manufacturers' Research Association. It is of interest to note that the 19·6 per cent organic matter stated by Tomes[8] to be present in dentine, instead of the 25–28 per cent still generally quoted, is the sum of the 18 per cent collagen and other organic constituents listed here.

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Lepidopterous Eggs and Larvæ from the Exterior of Aircraft Fuselages

All aircraft arriving from abroad at Whenuapai Airport, Auckland, New Zealand, are sprayed with an insecticidal aerosol and then searched for insect remains by mosquito control personnel of the Medical Branch of the Royal New Zealand Air Force.

During a routine search on May 6, 1950, a number of insect egg masses and emerging larvæ were collected forward of the aerial on the underside of the nose of an R.N.Z.A.F. Dakota (*DC3*) aircraft, on its arrival from Nausori Airport, Fiji. The eggs, most of them containing late embryos, were in aggregations of several hundred, the masses measuring up to 10 mm. × 6 mm. × 2 mm. They are spherical to sub-spherical in shape, the chorion being ribbed and reticulated, and are embedded in a mass of fine hairs. The body of the larva is furnished with short setæ, but has no secondary hairs. Tubercles vi and vii on the sixth abdominal segment each bears a single seta. This segment has well-developed prolegs bearing a number of crochets, the arrangement of which appears to be linear. The prespiracular wart on the thorax has two setæ, while in the case of both meso- and meta-thorax tubercle vii is furnished with but one seta. Thus, from Chu's key[1], the larvæ, while being of too early a stage for specific identification, appear to belong to the family Noctuidæ (Lepidoptera), which contains many pests of agricultural crops.

A further collection of egg masses, the structure of the eggs appearing to be identical with that of those just discussed, was made from beneath the wings of another R.N.Z.A.F. Dakota on its arrival at Whenuapai from Nandi Airport, Fiji, on June 10, 1950. Neither emergent larvæ nor late embryos were present in the material forwarded to me for examination. In the first instance described above, the aircraft had been on the ground at Nausori for approximately 88 hr., whereas in the second one the machine concerned had been at Nandi for only 40 hr. The minimum period elapsing between oviposition and hatching in the case of the moth under consideration is thus between 40 and 88 hr. From the fact that only a minority of the eggs collected from the first aircraft had hatched, this period is probably not very far short of 88 hr.

Senior White and Kirkpatrick[2] in Trinidad, B.W.I., and Dumbleton[3] in Aitutaki and Western Samoa, have already recorded lepidopterous eggs as being carried on the exterior of aircraft fuselages. The first-named authors were able to hatch out some of the eggs in the laboratory (estimated interval between oviposition and hatching, about 72 hr.), identifying them as being those of a noctuid moth near *Phytometra*. The eggs discovered by Dumbleton resemble those described in the present account in being sub-spherical and in having a sculptured chorion, also in being mixed with fine linear scales or hairs, but the lepidopterous family concerned was not determined.

It appears probable that the carriage of lepidopterous eggs on the exterior of aircraft fuselages is of more common occurrence than has previously been suspected. From the fact that emerging larvæ were present in the first instance reported from Whenuapai, the suggestion made by Senior White and Kirkpatrick that such larvæ might easily be swept away during flight and thus be deposited over perhaps hundreds of miles of countryside, so rendering possible the establishment of invasion foci, assumes added significance.

The use of DDT as a control agent to guard against such contingencies would be of little value, because the insecticide would be liable to be washed away by rain during flight. Careful polishing of the whole exterior of aircraft fuselages before take-off would seem to offer the most promising means of control, but such a procedure is not considered practicable. However, at least at those international airports where insect control personnel are available, some measure of control could be achieved by visual inspections of aircraft fuselage exteriors both before the commencement and after the completion of flights.

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Aug. 21.

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FORTHCOMING EVENT

Thursday, December 28

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 3 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "Waves and Vibrations". (Course of Lectures adapted to a Juvenile Auditory.) (Further Lectures on December 30, January 2, 4, 6 and 9.)

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

EDUCATIONAL PSYCHOLOGIST at the Reigate Child Guidance Clinic—The County Medical Officer, County Hall, Kingston-upon-Thames, Surrey (December 29).

TECHNOLOGIST, Grade I (with a good general training in chemistry, preferably up to degree standard)—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/275 (December 29).

FELLOWSHIPS IN EDUCATIONAL AND CLINICAL PSYCHOLOGY—The National Association for Mental Health, 39 Queen Anne Street, London, W.1 (December 30).

ASSISTANT ADVISORY OFFICER for work in the Grassland Husbandry Department—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (December 31).

CHAIR OF PARASITOLOGY at the University of Malaya—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (December 31).

LECTURER IN BOTANY, a SENIOR LECTURER IN AGRICULTURAL CHEMISTRY, a SENIOR LECTURER or LECTURER IN ECONOMICS, and a SENIOR LECTURER IN STATISTICAL METHODS, at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 31).

PASTURE AGRONOMIST IN THE DEPARTMENT OF VETERINARY SERVICES, Uganda—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27059/244 (December 31).

PASTURE OFFICER (to advise the Director of Agriculture and Veterinary Services on technical matters relating to pasture control), and SENIOR GRAZING OFFICERS (2, to work under the Pasture Officer), Somaliland Protectorate—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27059/259 (December 31).

CHIEF BIOCHEMIST in charge of the Endocrine Laboratory at Chelsea Hospital for Women—The Secretary, Queen Charlotte's and Chelsea Hospitals, 339 Goldhawk Road, London, W.6 (January 6).

DEMONSTRATOR (with honours degree in physics, and capable of carrying out research work in nuclear physics or related subjects, such as electronics) IN EXPERIMENTAL PHYSICS—The Registrar, The University, Liverpool (January 6).

RESEARCH OFFICER (Biophysicist) IN THE DIVISION OF ANIMAL HEALTH AND PRODUCTION, Fleece Analysis Laboratory, Sydney—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3147 (January 13).

CHAIR OF APPLIED MATHEMATICS—The Secretary, Queen's University, Belfast (January 15).

LECTURER IN PHYSICS at the University of Natal, Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 22).

PROFESSOR OF APPLIED MATHEMATICS at the University of the Witwatersrand, Johannesburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 31).

READER IN PATHOLOGY at the University of Adelaide—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 31).

BEIT FELLOWSHIPS FOR SCIENTIFIC RESEARCH—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7 (February 1).

SENIOR LECTURER IN CHEMICAL PATHOLOGY at the University of Otago Medical School, Dunedin—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (February 1).

LECTURER IN EDUCATIONAL PSYCHOLOGY—The Registrar, University College, Hull (February 10).

JUNIOR LECTURERS IN TROPICAL MEDICINE, PROTOZOOLOGY AND HELMINTHOLOGY—The Dean, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1 (February 28).

BEIT MEMORIAL FELLOWSHIPS FOR MEDICAL RESEARCH—The Secretary, Beit Memorial Fellowships for Medical Research, Lister Institute, Chelsea Bridge Road, London, S.W.1 (April 14).

ASSISTANT FORECASTER (with a university degree, preferably in science and specialized in meteorology, and able to issue weather forecasts independently) by the Government of Iraq for the Basrah Port Directorate—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.26338.E.

CHEMISTS (Experimental Officer grade) in Ministry of Supply Research and Development Establishments mainly in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.704/50A.

CHEMISTS and CHEMICAL ENGINEERS (Scientific Officer grade) in Ministry of Supply Experimental Establishments mainly in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.726/50A.

EDUCATIONAL PSYCHOLOGIST (woman)—The Chairman of Managers, Magdalen Hospital Classifying School, Drewstead Road, Streatham, London, S.W.16.

ENGINEER IN THE DEPARTMENT OF BROADCASTING, Malaya, to instal and manage broadcasting studios, recording channels and transmitters—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27326/39.

GRADUATE IN CHEMISTRY, to train for administrative position—The Director, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

HEAD OF THE DEPARTMENT OF PHYSICS AND MATHEMATICS—The Principal, West Ham Municipal College, Romford Road, London, E.15.

METEOROLOGISTS for the West African Meteorological Service—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27118/4.

NUTRITION OFFICER (woman) to investigate and advise upon nutrition problems, Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27321/4.

PHYSICIST (about 25) for work on publications—Dr. H. R. Lang, Institute of Physics, 47 Belgrave Square, London, S.W.1, endorsed 'Personal'.

PHYSICISTS AND MATHEMATICIANS (Experimental Officer grade) in Ministry of Supply Research and Development Establishments mainly in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.330/50A.

SCIENTIFIC ASSISTANT—The Commonwealth Bureau of Animal Health, Veterinary Laboratory, New Haw, Weybridge.

TECHNICAL ASSISTANT, male (Assistant Experimental Officer or Assistant (Scientific) grade)—The Secretary, John Innes Horticultural Institution, Bayfordbury, Herts.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Second Cape Catalogue of Stars for the Equinox of 1925·0, consisting of Part 1, Stars south of Dec. – 30°, Part 2, Zodiacal Stars, compiled from Observations made with the Reversible Transit Circle at the Royal Observatory, Cape of Good Hope, in the Years 1925–1933, under the direction of Dr. J. Jackson. Pp. xxiii+168+68. (London: H.M. Stationery Office, 1949.) 30*s.* net. [510

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Man and his Environment. By Prof. A. Leslie Banks. Pp. 16. (Cambridge: At the University Press, 1950.) 1*s.* 6*d.* net. [510

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Uganda Protectorate. Annual Report of the Forest Department for the Year ended 31st December 1949. Pp. iv+54+10 plates. (Entebbe: Government Printer, 1950.) 3*s.* [510

Memoirs of the India Meteorological Department. Vol. 28, Part 1: The General Characteristics of Squalls at Peshawar. By C. Ramaswamy and K. C. Majumdar. Pp. 53+9 plates. 7·8 rupees; 11*s.* 6*d.* **Vol. 28, Part 3: Rainfall at Peshawar.** By C. Ramaswamy and N. Suryanarayana. Pp. 121–138+7 plates. 3.6 rupees; 5*s.* 6*d.* (Delhi: Manager of Publications, 1950.) [510

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